APPENDIX B. COMPENSATION PLANNING FRAMEWORK (CPF)

CPF APPLICABILITY AND MITIGATION RULE COMPONENTS

The compensation planning framework adopts a landscape-watershed approach to selecting and implementing in-lieu fee mitigation projects that restore, enhance, establish and/or preserve aquatic resources under the IN SWMP program. This framework will be used to identify, evaluate, and screen potential IN SWMP mitigation projects and will be referenced in future Project Mitigation Plans.

The compensation planning framework includes the following ten elements required under 33 CFR §332.8 (c):

1. **Service Areas -** The geographic service area(s), including a watershed-based rationale for the delineation of each service area;
2. **Threats to Aquatic Resources -** A description of the threats to aquatic resources in the service area(s), including how the in-lieu fee program will help offset impacts resulting from those threats;
3. **Historic Aquatic Resource Loss -** An analysis of historic aquatic resource loss in the service area(s);
4. **Current Aquatic Resource Conditions -** An analysis of current aquatic resource conditions in the service area(s), supported by an appropriate level of field documentation;
5. **Aquatic Resource Goals and Objectives** - A statement of aquatic resource goals and objectives for each service area, including a description of the general amounts, types and locations of aquatic resources the program will seek to provide;
6. **Prioritization Strategy -** A prioritization strategy for selecting and implementing compensatory mitigation activities;
7. **Preservation Objectives -** An explanation of how any preservation objectives identified in paragraph (c)(2)(v) of this section and addressed in the prioritization strategy in paragraph (c)(2)(vi) satisfy the criteria for use of preservation in §332.3(h);
8. **Public and Private Stakeholder Involvement -** A description of any public and private stakeholder involvement in plan development and implementation, including, where appropriate, coordination with federal, state, tribal and local aquatic resource management and regulatory authorities;
9. **Long-Term Protection and Management -** A description of the long-term protection and management strategies for activities conducted by the in-lieu fee program sponsor;
10. **Periodic Evaluation Strategy -** A strategy for periodic evaluation and reporting on the progress of the program in achieving the goals and objectives in paragraph (c)(2)(v) of this section, including a process for revising the planning framework as necessary

The IN SWMP CPF provides a statewide approach with additional specificity within each of the 11 service areas. Elements nine and ten apply statewide and do not require additional specificity for each service area as they apply to the program as a whole.

STATEWIDE CPF

ELEMENT 1. SERVICE AREAS

1.1 Description

The IN SWMP will operate in 11 service areas listed below. The 8-digit HUC was used as the cataloguing unit for constructing the service areas. Two of the service areas are sized at an 8-digit HUC scale; the remaining service areas were configured by combining multiple 8-digit HUC watersheds. The following service areas were chosen based on a combination of watershed boundaries and the likelihood of future wetland and stream impacts and potential mitigation opportunities to offset those impacts (**Figure 1**). Ecoregions were also considered as a secondary priority in determining service area boundaries as most ecoregions do not coincide with watershed boundaries.

1. Calumet-Dunes
2. St. Joseph River (Lake MI)
3. Maumee
4. Kankakee
5. Upper Wabash
6. Middle Wabash
7. Upper White
8. Whitewater-East Fork White
9. Lower White
10. Upper Ohio
11. Ohio-Wabash Lowlands

The IDNR will provide mitigation credits for aquatic resource loss by completing projects in the same service area where the impact occurred. The threats, permitted impacts and historic loss within each service area will guide the IN SWMP landscape-watershed restoration goals, objectives and priorities in project selection, plan development, and implementation.

Indiana Stream and Wetland Mitigation Program Service Areas

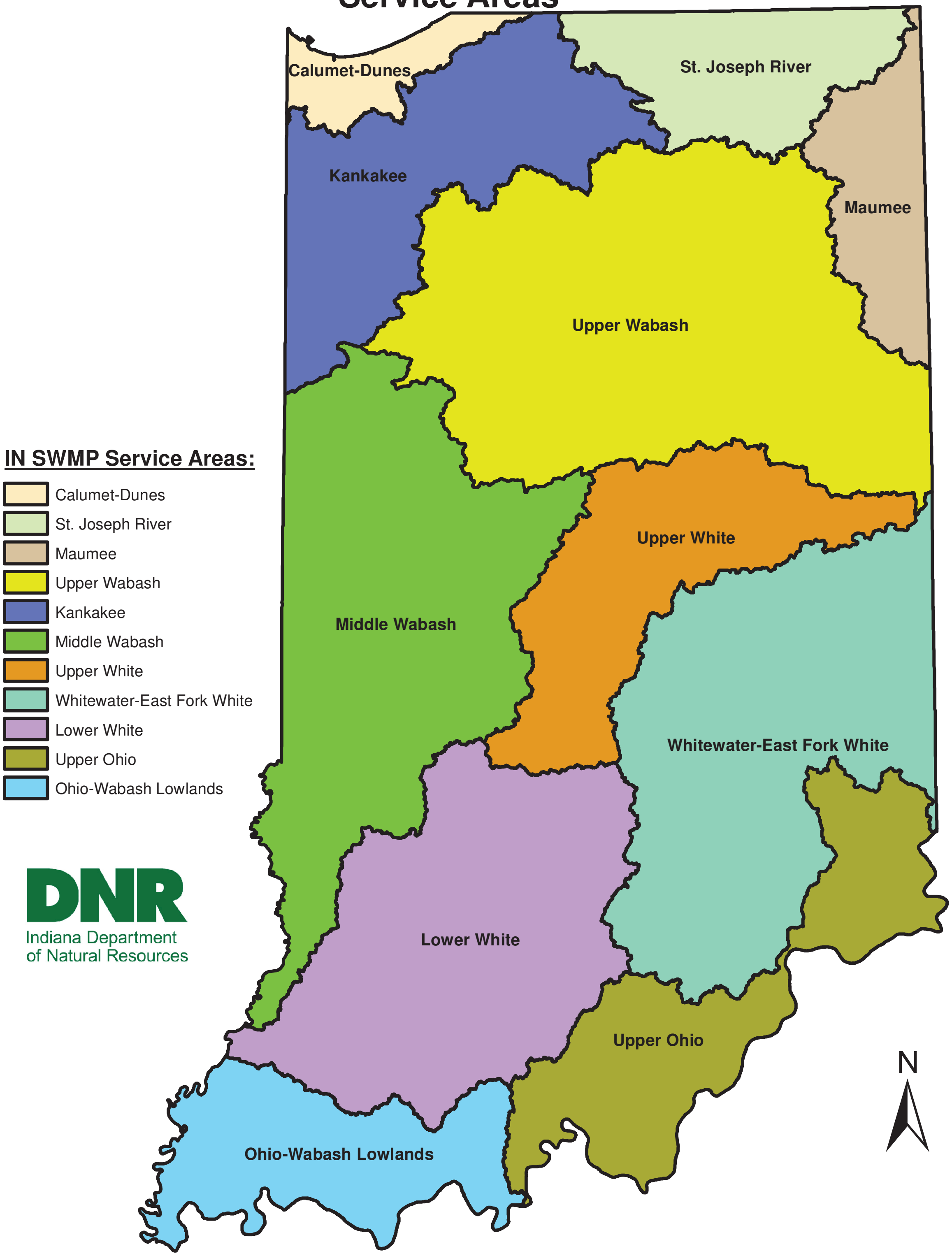

Figure 1. IN SWMP Service Areas

1.2 Rationale

The IN SWMP seeks to establish an option for mitigation that is environmentally preferable to permittee responsible mitigation. This will be accomplished by consolidating mitigation projects and resources, providing financial planning and scientific resource expertise and reducing uncertainty over project success. To achieve these results, the amount of fees collected by the IN SWMP must be sufficient to finance viable mitigation projects in each service area.

The State of Indiana is divided into 39 different 8-digit HUCs. The IDNR believes, based upon historical impact and mitigation data from the Corps and IDEM, that proposing a service area for each 8-digit HUC would result in numerous small service areas that would not experience enough impacts and therefore collect enough fees from the sale of credits over a period of three years to finance the required mitigation projects that would adequately compensate for permitted impacts to aquatic resources.

IDNR believes that the eleven service areas proposed will result in effective compensation for adverse environmental impacts to aquatic resources within each service area. The service areas, except the St. Joseph River and Upper White, are comprised of multiple 8-digit HUCs which IDNR biologists and ecologists believe have similar aquatic habitat systems and similar watershed characteristics.

The Calumet-Dunes Service Area includes two (2) 8-digit HUCs:

- 04040001 - Little Calumet-Galien
- 07120003 - Chicago

This service area is defined by the geologic and natural features associated with Lake Michigan and its origins. This includes morainal forests and prairies, lake plain wetlands, sand savannas, sand prairies, dune and swale habitat, swamps, and the sand dune and beach topography of the lake border. Northern wetland types characterize the entire area, especially associated with the Little and Grand Calumet Rivers. Much of the southern portion of this service area is within the Central Corn Belt Plains with glaciated plains that were historically extensive prairie communities that have been replaced by agriculture. The eastern half of this service area is within the Southern Michigan/Northern Indiana Drift Plains with a wide assortment of landforms, soil types, soil textures and land uses. The eastern half of this service area also has low to medium gradient streams and is home to paleobeach ridges, relict dunes, and morainal hills.

This service area has a relatively dense concentration of impacts, but has limited opportunities for wetland and stream restoration in each HUC compared to the rest of the proposed service areas. The Chicago HUC has a significant amount of impacts, but urbanization has reduced the accessibility to quality restoration opportunities. The Little Calumet-Galien HUC has significantly less historical impacts, but provides for greater opportunity to restore and rehabilitate wetlands and streams.

The St. Joseph River Service Area is a single 8-digit HUC:

- 04050001 - St. Joseph River

This service area has a distinctly different watershed outlet (the eastern shore of Lake Michigan) from the other 8-digit HUCs in Indiana. Complex glacial topography of moraines, kettles, kames characterize the service area which contains many of the highest quality wetland areas in the state, including lakes, peat lands, bogs, swamps, wet prairies as well as rich upland forests and prairies. Due to the large size of this HUC, the distinct drainage outlet, and the largely congruous northern lakes region occurring there, this single 8-digit HUC will be a distinct service area.

The Maumee Service Area includes parts of four (4) 8-digit HUCs (State of Indiana portions):

- 04100003 - St. Joseph (OH)
- 04100004 - St. Marys
- 04100005 - Upper Maumee
- 04100007 - Auglaize

The 8-digit HUCs in this service area all drain to Lake Erie. This service area captures the entire drainage basin of the Maumee River in Indiana: clearly distinguished from all other Indiana drainages by a continental divide. The natural communities are similarly related by headwaters streams draining forested morainal areas surrounding the flat Maumee lake plain (the Black Swamp). The majority of this service area is a transitional area between the Loamy, High Lime Till Plains and the Maumee Lake Plains. Soils are less productive and more artificially drained in this portion of the Eastern Corn Belt Plains ecoregion compared to the western and southern portions of this ecoregion in Indiana. The Maumee Lake Plains ecoregion is poorly-drained and contains clayey lake deposits, water-worked glacial till, and fertile soils. Elm-ash swamp forests and beech forests once were extensive but have been replaced by productive, drained farmland.

Due to the small size and common outlet of the watersheds as well as the similarities of the ecology within this service area, the partial 8-digit HUCs were combined to form this service area. The watersheds included in this service area are all headwater watersheds for the Maumee River.

The Kankakee Service Area includes portions of two (2) 8-digit HUCs:

- 07120001 - Kankakee
- 07120002 - Iroquois

The unifying feature of this service area is the Kankakee River. This area is bordered to the west by the prairie plains and moraines of the Iroquois River, to the east, the northern wetlands and forested moraines of the Plymouth area. The two HUCs of this service area are mostly included in the Central

Corn Belt Plains Ecoregion and both drain into the Illinois River. This ecoregion is characterized by the extensive flat, glaciated plains, wet prairies and bulrush-cattail marshes that were part of the sandy Kankakee drainage that has been converted to farms on the dark and fertile soils of this ecoregion. Additionally, these HUCs were combined to ensure sufficient credit sales within the service area. Individually, these HUCs individually have not had impacts such that they would support a financially viable service area on their own.

The Upper Wabash Service Area is a combination of seven (7) 8-digit HUCs:

- 05120101 - Upper Wabash
- 05120102 - Salamonie
- 05120103 - Mississinewa
- 05120104 - Eel
- 05120105 - Middle Wabash-Deer
- 05120106 - Tippecanoe
- 05120107 - Wildcat

These HUCs are largely rural, experiencing population declines, have had relatively few historical impacts requiring mitigation, and are primarily headwater watersheds. While this is a relatively large geographic area, this service area is characterized throughout by the forested tributaries of the upper Wabash River and Tippecanoe River. These HUCs drain the plains and landscape features that have a Wisconsinan glaciation origin. This service area contains both the Eastern Corn Belt Plains and the Southern Michigan/Northern Indiana Drift Plains Ecoregions; the ecology of the HUCs is similar across the service area. Most of the latter ecoregion within this service area is the Middle Tippecanoe Plains, a Level IV ecoregion that is better to include from an ecological perspective with the other Upper Wabash watersheds of this service area that are part of the Clayey, High Lime Till Plains that were also historically forested. Dividing this service area would create numerous smaller service areas that are not likely to be financially viable for the program when looking at the historical impact data.

The Middle Wabash Service Area includes all or part of six (6) 8-digit HUCs:

- 05120108 - Middle Wabash-Little Vermilion
- 05120109 - Vermilion
- 05120110 - Sugar
- 05120111 - Middle Wabash-Busseron
- 05120113 - Lower Wabash (small portion)
- 05120203 - Eel

This service area, while a relatively large geographic area, it is unified physiographically by the many distinct and highly incised and dendritic tributaries draining into the Central Wabash Valley. It was an area dominated by mixed deciduous forests. This includes streams of the central tillplain, as well as the Wabash lowlands and geologically older plains to the south. The Eel 8-digit HUC was included in the Middle Wabash Service Area due to fewer impacts within the remainder of the service area when compared to the relatively higher number of impacts in the Upper White Service Area and the Lower White Service Area. Also, the lower half of the Eel River watershed is within the Interior River Valleys and Hills ecoregion making it arguably more appropriate from an ecological perspective to be included in this service area rather than either the Upper White or the Lower White. Combining these HUCs into one service area should also ensure that it will remain financially viable for the program long-term.

The Upper White Service Area is defined as a single 8-digit HUC:

- 05120201 - Upper White

This service area includes the city of Indianapolis and the surrounding suburbs which have a relatively high volume of impacts based on the Corps and IDEM data from 2009 to 2015. The service area is a relatively uniform region of forested streams and a poorly drained, formerly forested, level tillplain that has been converted to agriculture and more recently for urban sprawl.

The Whitewater-East Fork White Service Area includes all or parts of seven (7) 8-digit HUCs:

- 05120204 - Driftwood
- 05120205 - Flatrock-Haw
- 05120206 - Upper East Fork White
- 05120207 - Muscatatuck
- 05080001 - Upper Great Miami
- 05080002 - Lower Great Miami
- 05080003 - Whitewater

This service area includes 8-digit HUCs that are nearly entirely within the Eastern Corn Belt Plains Ecoregion. The area is characterized by the deeply incised Whitewater River valley to the east, and the flat, often poorly drained, headwaters of the East Fork White River, including the Muscatatuck River. It was an area of similar types of largely forested plant and animal communities, including many wetlands associated with stream corridors. The Whitewater River watershed was included in this service area with the East Fork White as opposed to the Upper Ohio service area after taking into consideration the ecoregions of this portion of the state.

The Lower White Service Area is a combination of three (3) 8-digit HUCs:

- 05120202 - Lower White
- 05120208 - Lower East Fork White
- 05120209 - Patoka

While large, and being comprised of two different ecoregions fairly equally, this service area is defined by the drainages of the lower stretches of both the East and West Forks of the White River to their confluence with the Wabash River. This includes the rugged topography and bedrock hills of unglaciated south-central Indiana. Large areas of karst plain topography are also present. Further west in the drainages, the land abruptly transitions to the broad level plains of the Wabash River lowlands. The entire service area was forested, with many affinities to southern woodland types. The rugged uplands possess very few wetland soil types outside of those directly associated with stream channels. However, the western lowlands, especially along the lower West Fork White and Patoka River, contain significant areas of hydric soils and existing wetlands. Individually, each of these 8-digit HUCs within this service area has not had historical impacts that required mitigation between 2006 and 2013 for each watershed to serve as an individual service area. Additionally, each of these three watersheds spans two ecoregions. Therefore, combining these three 8-digit HUCs into one service area creates what IDNR believes will be an ecologically and financially viable service area for the lifetime of the program.

<u>The Upper Ohio Service Area</u> includes three (3) 8-digit HUCs:

- 05090203 - Middle Ohio-Laughery
- 05140104 - Blue-Sinking
- 05140101 - Silver-Little Kentucky

These HUCs were combined into this service area since all three watersheds drain through fairly short basins into the Ohio River. While this service area is composed of two ecoregions, these HUCs share some ecologic similarities, primarily being composed of southern forests, including barrens and glades, on hilly to very rugged topography that was primarily unglaciated. Significant areas of karst topography are also present in much of this service area.

Additionally, the Corps and IDEM impact data show a small area of concentrated impacts with relatively few impacts in the remainder of the service area. Therefore, due to the ecological similarities and from studying the historical impact data, IDNR believes that combining these three HUCs into one service area will provide an ecologically and financially viable service area for the lifetime of the program.

<u>The Ohio-Wabash Lowlands Service Area</u> includes all or part of three (3) 8-digit HUCs:

- 05120113 - Lower Wabash
- 05140201 - Lower Ohio-Little Pigeon
- 05140202 - Highland-Pigeon

These HUCs drain into the Wabash and Ohio River and share many natural features. The extensive river bottom lowlands of this service area possess significant wetland resources. Many small streams drain the eastern hills region along short drainages directly into the Ohio River. The majority of this service area is within the Interior River Valleys and Hills ecoregion. While less than half of the Lower Ohio-Little Pigeon watershed is within the Interior Plateau ecoregion, it wasn't ecologically different enough to justify splitting this 8-digit HUC into two separate service areas. While the Corps and IDEM data show fairly evenly distributed impacts across the entire service area, the IDNR does not believe there will be a sufficient number of impacts in each individual 8-digit HUC in a three-year period for them to stand alone as individually as service areas and still remain ecologically and financially viable for the lifetime of the program.

ELEMENT 2. STATEWIDE AQUATIC RESOURCE THREATS

<u>2.1 Threats to Indiana's Aquatic Resources</u>

Many projects and human activities convert land and resources from one type or use into another to achieve a goal with a perceived benefit. The majority of these anthropogenic activities, primarily aquatic system, and upland conversions and modifications, greatly alter in aggregate the natural functions and services of Indiana's aquatic resources and dependent habitats. As a result, there are many common threats to aquatic resources across Indiana; and in conjunction with permitted impact trends, historic loss and current watershed conditions, warrant significant consideration in the statewide foundation of the IN SWMP goals, objectives and prioritization strategies.

In this analysis, threats are catalogued from the perspective of the aquatic resources, botanical resources, and dependent wildlife and habits that experience the impacts of those threats. Threats to Indiana's streams, rivers, lakes and wetlands, and the ecological functions and services they provide, are described and categorized based on the major land and aquatic resource conversion activities which in themselves' are the main sources of direct and indirect threats that contribute to aquatic resource and habitat alteration, fragmentation, impairment and loss. Threats can be residual, current/ongoing or anticipated in the future.

The predominant threats to aquatic resources and habitats throughout Indiana as a result of anthropogenic activities include, but are not limited to, the following:

- Habitat conversion
- Habitat alteration
- Habitat fragmentation
- Habitat degradation
- Aquatic resource loss
- Altered surface and groundwater hydrology
- Increased and accelerated erosion and sedimentation

- Stream channelization
- Stream instability
- Loss and/or impairment of aquatic system functions and services
- Point source pollution
- Non-point source pollution
- Invasive and non-native species

The major anthropogenic categories of activities, both historic and ongoing, that have resulted in the above-listed threats to the chemical, physical and biological integrity of aquatic resources and habitats across Indiana include, but are not limited to the following:

- **Growth and Development:** Residential, commercial and industrial developments and land use, urban areas, suburban areas, towns, waste and drinking water treatment plants, airports, local utilities and easements, local roads, train yards, golf course, parks, campgrounds, landfills.
- **Agricultural Land Use:** Cultivated crops, livestock grazing, hay/pasture lands.
- **Dams, Levees and Non-Levee Embankments:** High head dams (instream dams impounding water such as reservoirs), low head (in-channel) dams, flood control levees and flood walls, non-levee embankments.
- **Energy Production and Mining:** Coal mining, mineral and gravel mining, and oil and gas production.
- **Transportation and Service Corridors:** Interstates, federal and state highways, railroads, bridges, culverts, oil and gas pipelines, electric transmission lines, shipping lanes and regional utility easements.

These categories of major anthropogenic activities and resulting common threats are based greatly on Section 404 Department of the Army permitted impact trends from 2009 to 2015 (Chicago, Detroit and Louisville Corps Districts); the 2015 Indiana State Wildlife Action Plan (SWAP) (SWAP, 2015); the Indiana Wetlands Program Plan (IWPP, 2015); historic loss of aquatic resources determined primarily from land cover changes from pre-settlement to the present; and IDEM's aquatic resource and habitat assessment data (305b Assessments, 303(d) Listing; Impairment Sources) (IDEM-IR, 2016). Similar to the Indiana State Wildlife Action Plan, IN SWMP has adopted the approach to characterizing the threats to Indiana's aquatic resources and their contributing factors that is established in Salafsky, et. al., *A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions* (Salafsky, et al., 2008).

IDNR analyzed the project work type descriptors of the Corps provided Section 404 permit data for stream and wetland impacts requiring mitigation from 2009 to 2015 in order to identify the permitted activities with one of the five broad major anthropogenic categories above. For example, if the purpose of bank stabilization was to protect a state highway, the impact was categorized as "transportation". If a bank stabilization project's purpose was to protect a residential property, the impact was categorized in "growth and development".

IDNR completed this analysis for the 2009-2015 dataset and summarized that analysis in **Figures 2 and 3** below. Energy Production, which includes coal mines, is the dominant category. Transportation and Development are, by comparison, much smaller.

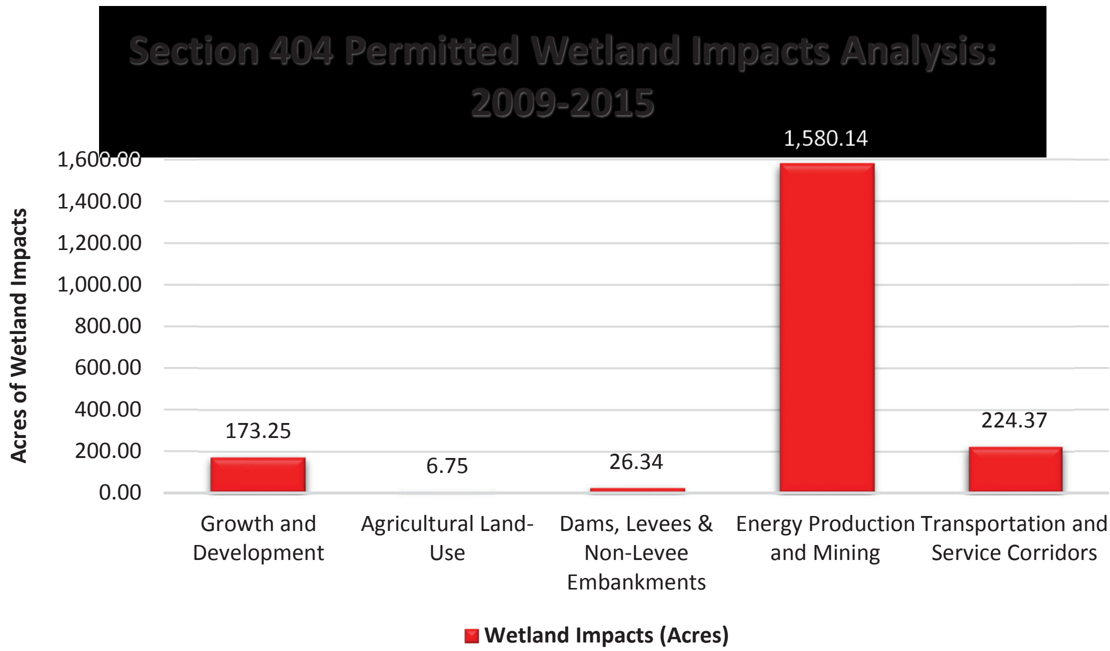

Figure 2. Section 404 permitted wetland impacts that required mitigation from 2009-2015.

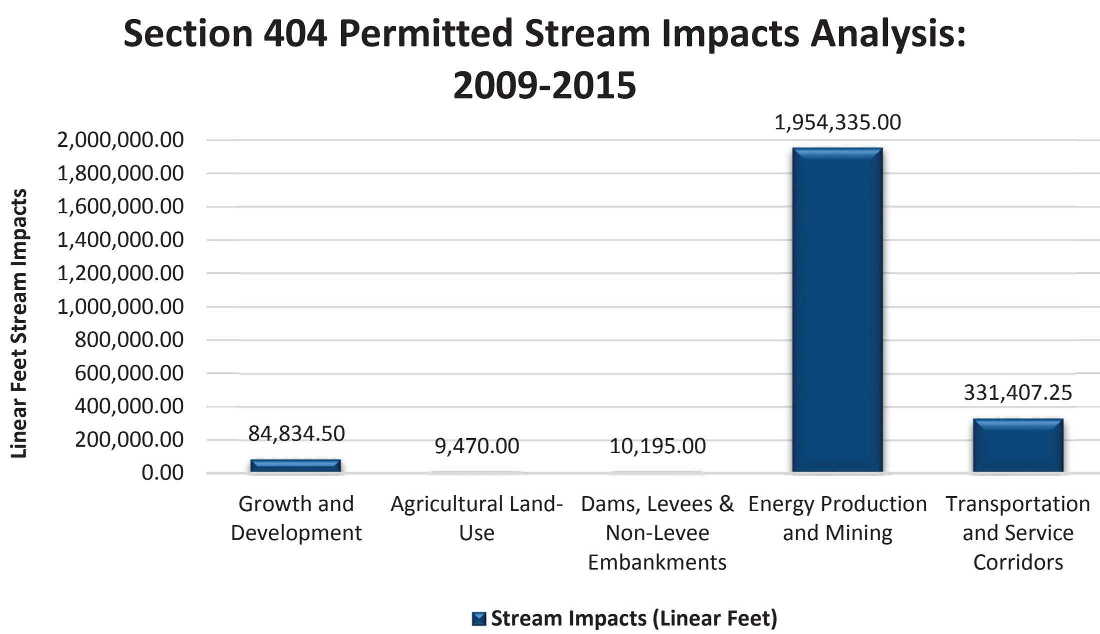

Figure 3. Section 404 permitted stream impacts that required mitigation from 2009-2015.

While the IDNR is not expecting that these large impacts would be mitigated through IN SWMP, it is not out of the realm of possibility that IN SWMP could be utilized at some point in the future to fulfill mitigation requirements for some of these impacts, therefore, IDNR has included all impacts that required mitigation in **Figures 2 and 3**. Additionally, in several service areas, energy production and mining remains the predominant threat to aquatic resources and warrants discussion in this document.

While agriculture and dams have not had a significant number of permitted impacts, mostly due to permitting exemptions and the nature of the aquatic resource impacts predate protection under the Clean Water Act and State regulations; however, their presence on the landscape along with the ongoing and/or potential future threats from historic land and habitat conversions warrants that they be discussed as major categories of anthropogenic impacts to Indiana's aquatic resources.

2.2 Major Anthropogenic Categories of Impacts

Authorized Section 404 and state isolated wetland permitted activities that exceed the impact thresholds of general permits typically require compensatory mitigation to help offset impacts to aquatic resources, which has predominantly been completed by the permittees. Compensatory mitigation carried out by IN SWMP for the authorized sale of advance credits to permittees will be conducted through stream and/or wetland restoration, enhancement and/or preservation activities to help offset threats from the identified major anthropogenic categories that impact aquatic resources while considering historic loss and current conditions. Proposed mitigation acitivties to help offset the identified threats are discussed at the conclusion of each of the five major categories deliberated in this section below. Additionally, a summary of offsets per major anthropogenic category and a general threat-offset activity matrix is provided in **Appendix C.**

2.2.1 Impacts from Growth and Development

Population growth, and residential, commercial and industrial development are major contributors to the alteration, conversion, degradation and loss of aquatic resources statewide. In addition to historical conversion and loss, Indiana's aquatic resources continue to be impacted by population growth, urban and suburban expansion, encroachment, deforestation, industrial effluent, storm water management, channelization, and a resulting decline in water quality (Amlaner & Jackson, 2012). The Indiana SWAP identifies residential, commercial and industrial areas, and haphazard urban sprawl, as some of the top ranked threats to all major habitat types statewide (SWAP, 2015). The Indiana Wetlands Program Plan (IWPP) recognizes increased development, aquatic resource conversion, declining quality and increased quantity of runoff from urban and suburban landscapes, and the fragmentation of habitats as major threats to Indiana's remaining wetlands (IWPP, 2015). Additionally, IDEM identifies urban runoff, construction (site clearing), loss of riparian habitat, streambank modifications, hydromodification, municipal and industrial discharges, and failing septic systems as major sources impairing Indiana streams (IDEM-IR, 2016).

2.2.1(a) Developed Land and Threats to Aquatic Resources

Aquatic resource conversion and loss, in addition to ongoing land uses, have significant impacts on aquatic resources and habitats in developed areas. Urban sprawl, commonly considered dispersed and inefficient urban growth, often results in loss of natural wetlands, core forest and riparian habitats, and an increase in impervious surfaces (Hasse & Lathrop, 2003). As cities expand into rural areas, large tracts of land become developed with varied land uses such as housing, retail stores, offices, industry, recreation facilities and public spaces, and are usually kept separate through zoning (Frumkin, 2002). Until recent history, the majority of existing urban developments were built without much consideration for water quality protection with the objective of using the land to its greatest potential for the planned land use (IDEM-Storm Water, 2007).

Increased impervious surfaces in developed areas intensify storm water runoff carrying pollutants such as oils and grease, sediments, bacteria, pesticides, fertilizers, metals, salts and other pollutants (Tedesco & Salazare, 2006). Additionally, urban snow melt runoff can contain accumulated concentrations of pollutants, particulates, salts and litter that can contribute substantial portions of an annual load of pollutants resulting in a significant threat to water quality (Oberts, 2000). For an example of developed land use impacts to aquatic resources, in Indiana's most developed watershed, a decline in water quality has been well documented in the White River Basin, which includes high turbidity, high bacteria counts, poor chemical quality, degraded habitat and reduced biodiversity, and is largely attributed to the urban centers (Martin, Crawford, Frey, & Hodgkins, 1996). Specifically in the Upper West Fork White River, nutrient concentrations were higher downstream of Muncie, Anderson and Indianapolis than upstream of the cities due to much larger volumes of treated municipal sewage, combined-sewer overflows, and urban runoff (Frey et al, 1996) (Martin, Crawford, Frey, & Hodgkins, 1996).

The changes in land use associated with urban development also affect flooding in many ways. The removal of vegetation and soil, grading the land surface, impervious surfaces, and the construction of drainage networks in urban/suburban areas, results in increased peak discharge volume and frequency in streams (Konrad, 2003). As a result of larger and more frequent discharges correlated with urbanization within a watershed, the geometry and stability of stream channels are altered through widening and down cutting, or a combination of both (Caraco, 2000). The resulted increases in width and depth are roughly proportionate to the increase in peak flows (Booth, 1990). Of the many riverine functions and services impacted by urbanization; stream evolution, riparian succession, erosion, sedimentation and sediment transport processes, instream and riparian habitat, and biological community processes are most likely to be impacted (Shochat, et al., 2010). The accelerated degradation of channel physical integrity often leads to increases in stream bank armoring, which affects stream functions and services such as morphological evolution, riparian succession, hydrologic balance, sediment processes, habitat, and chemical and biological processes (Fischenich, 2003).

The responses of stream biological condition are strongly influenced by localized landform and land use, and urban streams often have degraded habitats and reduced biological diversity as a result of urban stressors (Allan, 2004). A significant amount of documented research indicates that urban fish and invertebrate assemblages are typically species poor due to factors such as flashy hydrographs, low habitat diversity and high contaminant loads (Bernhardt & Palmer, 2007). This reduction in biotic richness typically results in an increased dominance of tolerant species, and a decrease in sensitive species in both fishes and macroinvertebrates (Waslsh, et al., 2005). Transformation of natural land cover to developed use alters vegetation structure, lowers biodiversity, and is responsible for the extirpation of many native plants from urban settings (Shochat, et al., 2010); (Amlaner & Jackson, 2012). Reductions in riparian areas and canopy cover reduce shading, increase stream temperatures, decrease bank stability, increase bank and channel erosion, and cause substantial changes in biological assemblages (Allan, 2004). Additionally, densely populated urban areas are typically hotter than surrounding rural areas, the effect known as “urban heat islands” (U.S. EPA, 2016). The increase in paved surfaces and rooftops, as well as the reduction in tree cover and stream shade in urban areas, increases the temperature of run-off which raises water temperatures of aquatic resources in an urbanized watershed (U.S. EPA, 2016).

Though urbanization in a watershed is highly influential to streams, stream conditions are also strongly influenced by the directly adjacent landscape; therefore, the physical integrity of degraded stream reaches can improve, especially if the riparian area is substantially forested and devoid of road crossings (McBride & Booth, 2005). On the contrary, as floodplain encroachment is typically more intensified in developed areas, the concentrated infrastructure interferes with the streams’ natural meander belts (fluvial erosion hazard areas), which negatively impacts fluvial and floodplain processes as the waterway shifts its position across the landscape over time (Indiana Silver Jackets, 2016). The number and density of stream crossings, either bridges or culverts, are greater in developed areas, and result in negative cumulative impacts of riparian areas, stream flow dynamics and fluvial processes. Bridges and culverts can reduce channel and floodplain cross-sectional flow area; create backwater and increase upstream flood elevations; increase velocities and shear stress increasing scour and stream instability; accumulate debris causing blockage and increase shear stress on the structure and adjacent banks; and create hydraulic jumps and downstream plunges (U.S. DOT, 2012).

The effects of urbanization on hydrology, geomorphology and ecology also cause wetlands in urban areas to function differently than wetlands in less disturbed settings (Ehrenfeld, 2000). A decrease in evapotranspiration, interception, and infiltration in urban landscapes greatly alters the water balance and natural hydrological cycle, resulting in stressed hydrologic budgets for wetlands in urban areas (Tong & Chen, 2002). Other than major wetland loss and fragmentation due to filling and draining; urban wetland degradation is caused by changes in water quality, quantity, surface flow, non-native species, physical disturbances, sedimentation, and the full host of urban and industrial pollutants (U.S. EPA, 2001). Sediment accumulation in wetlands can reduce their capacity to retain storm water and their value to wildlife (IDEM-Storm Water, 2007). Additionally, the quantity and quality of water available for ground water recharge and stream base flow is greatly reduced (Tong & Chen, 2002). These water budget stressors can also affect reaches of urban streams with an intact riparian area when for example an incised channel in combination with piped storm water drainage and increased impervious surfaces results in a lowered water table reducing riparian benefits such as nutrient and pollutant uptake moving through shallow ground water flow (Groffman, et al., 2002).

2.2.1(b) Changes in Land Use for Development

As Indiana's population increased from 2000 to 2010, so did the area of developed land cover. Evaluation of the 2011 National Land Cover Database (Homer, et al., 2015) indicates Indiana's developed land cover increased 4.45 percent from 3,748 square miles (10.29% total cover) in 2001, to 3,922 sq. mi. (10.77% total cover) in 2011 (**Figure 4**), for a total gain of 174.55 sq. mi. (111,712 acres). Not only did developed land cover increase, but the intensity of existing developed land cover increased as the area of impervious surface gained 9.45 percent in the same decade. Agricultural lands gave up the most land cover to developed areas at 134.72 square miles (86,220.8 acres) of cultivated crops and hay/pasture. This trend is continuing from previous decades. From 1950 to 2007, Indiana's agricultural acreage decreased 24 percent and the population increased by 2.4 million (63%) (Hall, 2010). A summary of land cover change for development can be found in **Table 1**.

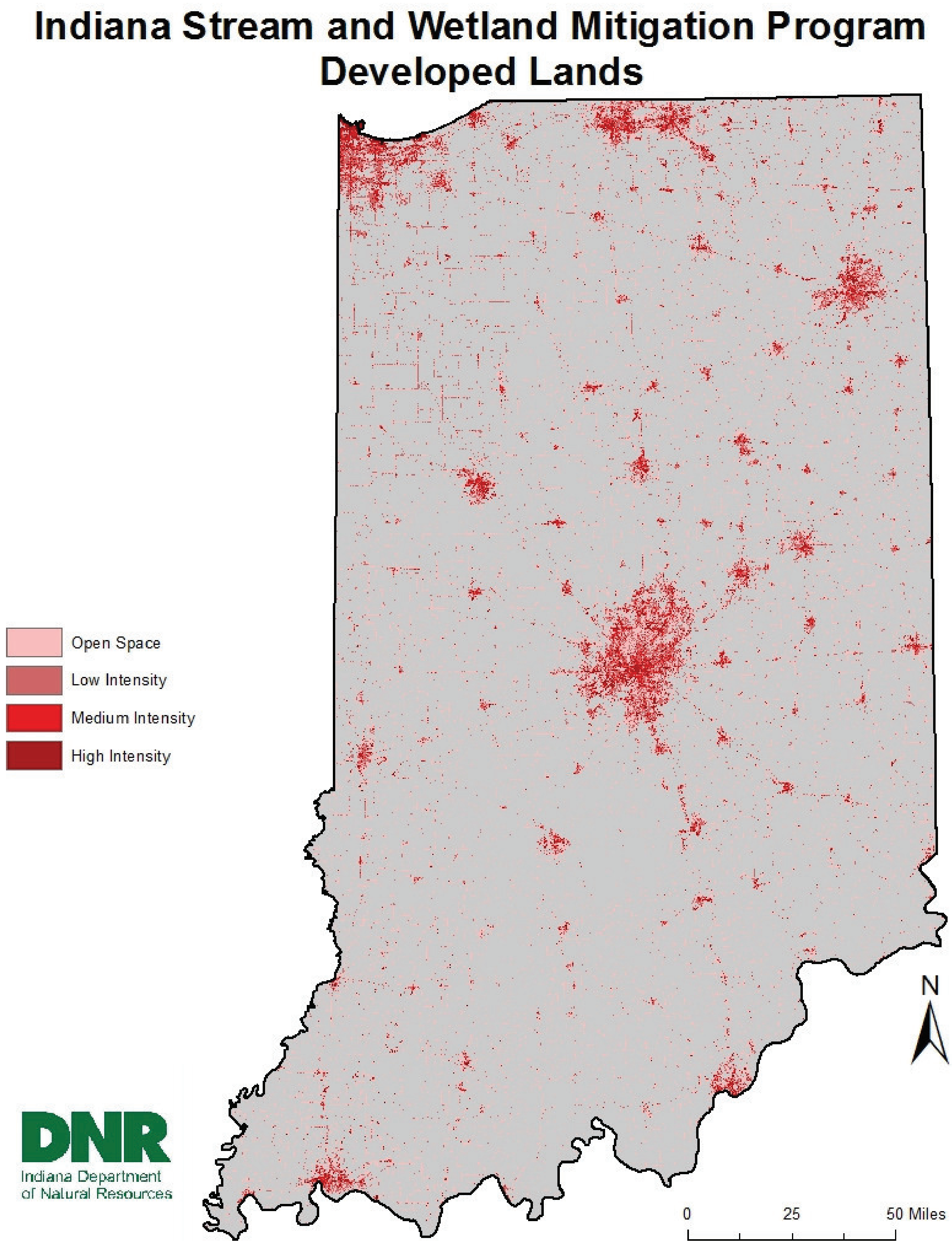

Figure 4. Indiana's Developed Areas as of 2011, 2011 NLCD, (Homer, et al., 2015)

Land Cover	Changed to Developed 2001-2011 (Square Miles)	Changed to Developed 2001-2011 (Acres)
Open Water (WTR)	1.11	710
Barren Land (BAR)	1.18	755
Deciduous Forest (DFS)	17.51	11,206
Evergreen Forest (EFS)	0.49	313.60
Mixed Forest (MFS)	0.29	185
Scrub/Shrub (SCB)	3.09	1,977
Grassland/Herbaceous (GRS)	11.1	7,104
Pasture/Hay (PSH)	18.77	12,012
Cultivated Crops (CLC)	115.95	74,208
Woody Wetlands (WDW)	3.87	2,476
Emergent Herbaceous Wetlands (EMW)	1.19	761.60
Total	174.55	111,712

Table 1. Land cover change to developed areas from 2001 – 2011, NLCD, (Homer, et al., 2015)

2.2.1(c) Population Distribution and Growth Trends

Indiana has experienced population growth through natural increase (i.e., more births than deaths) and net migration into the state since admittance into the Union as the 19th state in December of 1816 (Indiana LTAP, 2011). Indiana's present day population centers were well established and growing communities shortly after the turn of the 20th century, and accounted for the majority of early census figures (Indiana LTAP, 2011). Over the past several decades, metropolitan areas have accounted for the majority of growth through both natural increase and net migration into the state (Kinghorn M. , 2012), while the majority of rural areas consisting of agriculture and smaller towns are experiencing a net emigration (Waldorf, Ayres, & McKendree, 2013). Any net emigration of rural areas has historically been offset by natural increase, though recent trends show that 29 rural and rural/mixed counties have experienced a decline in population (Kinghorn M. , 2011).

The U.S. Office of Management and Budget (OMB) defines a Metropolitan Statistical Area (MSA) as a core urban area with a population of at least 50,000, and any adjacent counties that are highly integrated socially or economically to include commuting ties (25% or more commute) (U.S. OMB, 2013). The Census Bureau defines rural as an area that encompasses all population, housing and territory not included within an urban area of 2,500 or more people, which are defined as a Micropolitan Statistical Area (U.S. Census Bureau, 2010).

Indiana has 15 MSA's (**Table 2**), each within one or more service areas, with the Gary Metro Area being a division of the Chicago MSA since nearly 8.8 million of the 9.5 million people in the Chicago MSA are located outside of Indiana (Manns, 2013).

Based on the U.S. OMB MSA definitions, as of 2010, 44 of Indiana's 92 counties belong to one of 15 MSAs (**Table 2**), accounting for 77.5 percent of Indiana's total population; and 15.5 percent live in one of 25 counties in 24 Micropolitan Statistical Areas (combined at 93 percent), leaving only 7.1 percent of the population not part of a statistical area within one of 23 rural counties (Kinghorn M. , 2016).

The Purdue University Center for Rural Development further classifies Indiana counties, because many counties with a predominantly rural character may be classified as urban if located within an MSA (Ayres, Waldorf, & McKendree, 2013). The center has delineated Indiana counties into three classifications of Rural, Rural/Mixed and Urban, based on the population being either less than 40,000, 40,000 to 100,000, or over 100,000 respectively (Ayres, Waldorf, & McKendree, 2013). Considering Purdue's definition, analysis of the 2010 census indicates of the 42 counties considered to be rural, 24 counties had an increase in population while 18 counties experienced a decline in population. Population declines in Indiana have mainly been experienced in rural areas or historically industrial communities where job losses have been more prevalent (Kinghorn M. , 2011). Though Purdue's Center for Rural Development definition has Indiana's rural population at 14 percent in 42 counties, Urban and Rural/Mixed populations still dominate Indiana with a combined 86 percent under the Purdue University classification system.

Though Indiana has lost manufacturing jobs, the long-term economy is difficult to predict, and there could be a positive shift in this sector as industry diversification, economic growth and tight labor markets could stimulate a greater than expected net immigration in the coming decades (Kinghorn M. , 2012). Indiana has a strong business culture that provides an array of corporate tax incentives and credits, and as such, the corporate income tax is decreasing from the current 6.5% to 4.9%, which will be phased in by 2021 (IEDC, 2016). Furthermore, Indiana provides prospective business, communities and the workforce with economic development programs, regulatory assistance, grants, and resource and technical assistance through the Indiana Economic Development Corporation (IEDC). Additional incentives and resources for economic development in Indiana are offered by the Indiana Office of Community and Rural Affairs; the Indiana Department of Workforce Development's Economic Growth Regions; and the Indiana Association of Regional Councils currently comprised of 15 Regional economic and planning commissions, councils and/or districts across the state.

Metropolitan Statistical Areas	Counties and Service Areas	2010 Population	Percentage of Growth or Decline 2000 – 2010
Chicago* (Gary Metro Division)	Lake, Porter, Newton, Jasper **SA's:** Calumet-Dunes, Kankakee, Upper Wabash	708,070	4%
Michigan City-LaPorte	LaPorte **SA's:** Calumet-Dunes, Kankakee	111,467	1.2%
South Bend-Mishawaka	St. Joseph **SA's:** St. Joseph, Kankakee	319,224	0.8%
Elkhart-Goshen	Elkhart **SA's:** St. Joseph, Kankakee	197,559	8.1%
Fort Wayne	Allen, Whitley, Wells **SA's:** Maumee, Upper Wabash	416,257	6.7%
Lafayette-West Lafayette	Tippecanoe, Benton, Carrol **SA's:** Kankakee, Upper Wabash, Middle Wabash	201,789	13%
Kokomo	Howard **SA:** Upper Wabash	82,752	-2.6%
Muncie	Delaware **SA's:** Upper White, Upper Wabash	117,671	-0.9%
Indianapolis-Carmel-Anderson	Marion, Boone, Hamilton, Madison, Putnam, Hendricks, Hancock, Morgan, Johnson, Shelby, Brown **SA's:** Upper White, Whitewater-EF White, Upper Wabash, Middle Wabash, Lower White	1,887,877	13.8
Terre Haute	Vermillion, Vigo, Clay, Sullivan **SA's:** Middle Wabash, Lower White	172,425	0.9%
Bloomington	Monroe, Owen **SA's:** Lower White, Upper White, Middle Wabash	159,549	12.1%
Columbus	Bartholomew **SA's:** Whitewater-EF White, Lower White	76,794	7.5%
Cincinnati*	Union, Dearborn, Ohio **SA's:** Whitewater-EF White, Upper Ohio	63,691	6%
Louisville-Jefferson County*	Clark, Floyd, Harrison, Scott, Washington **SA's:** Whitewater-EF White, Upper Ohio, Lower White	276,617	10.2%
Evansville	Posey, Vanderburgh, Warrick **SA's:** Ohio Wabash Lowlands, Lower White	265,302	5.2%
Total	44	5,057,044	8.8%

Table 2. Metropolitan Statistical Areas and percent growth from 2000 – 2010 (IDNR combined analysis of Indiana Business Research Center and U.S. Census Bureau data) *Metros with at least one county outside Indiana's boundaries – 2010 Population only for Indiana counties within MSAs. (Manns, 2013)

Though Indiana is a historically predominant agricultural and industrial manufacturing state, the Indiana Career Council, in conjunction with other public and private sector partners, developed a strategic plan to transform Indiana's workforce with post-secondary skills and credentials in a diversity of sectors such as health sciences, information technology, transportation and distribution logistics, energy production and distribution, and advanced manufacturing with the goal of growing the economy (Indiana Career Council, 2014).

2.2.1(d) IN SWMP Offsets for Growth and Development Impacts:

Since urban growth and development continues to increase, helping to offset impacts within and adjacent to developed areas is ecologically important. IN SWMP will help offset impacts from growth and development by targeting compensatory mitigation projects utilizing a watershed approach within and adjacent to developed land uses, in which will help improve the quality and quantity of aquatic resources and dependent habitats unique to the landscape watershed needs within each service area. Those offsets include:

- Restoring wetlands and/or riparian areas upstream of developed areas to help provide floodplain storage, attenuation of peak flow discharges, relieve hydraulic pressures of reduced urban and suburban cross-sectional flow areas, and improve/increase aquatic resource functions, services, water quality and/or habitat quality.
- Conducting stream and river channel restorations that help to provide more natural conditions to improve fluvial processes and facilitate ecological recovery.
- Restoring wetlands, riparian areas and/or stream and river channels within developed areas where reasonably appropriate to help provide floodplain storage, attenuate peak flow discharges and velocities, promote increased channel and floodplain connectivity, establish functional native vegetative buffers from adjacent land use impact sources, connect riparian corridors, improve habitat, and/or improve natural fluvial processes.
- Pursuing wetland, riparian and/or stream/river channel restoration opportunities downstream of developed areas to help improve aquatic resource functions and services, water quality, habitat and/or riparian corridor connectivity to help offset upstream developed land use impacts.

2.2.2 Agricultural Land Use Impacts

Agricultural land uses have made a significant contribution to the conversion, degradation, alteration, and loss of aquatic resources on a statewide scale (**Figure 5**). Indiana ranks fifth in agricultural row-crop production and tenth in all agricultural commodities within the United States (Indiana State Department of Agriculture, 2014). Although Indiana is a top producing agricultural state, the majority of active row-crop production is on farm ground that has been historically converted from wetlands. Approximately 54.8% of Indiana's land use is dominated by agriculture (Homer, et al., 2015), and a majority of wetlands in Indiana have been and continue to be lost as a result of agricultural drainage practices.

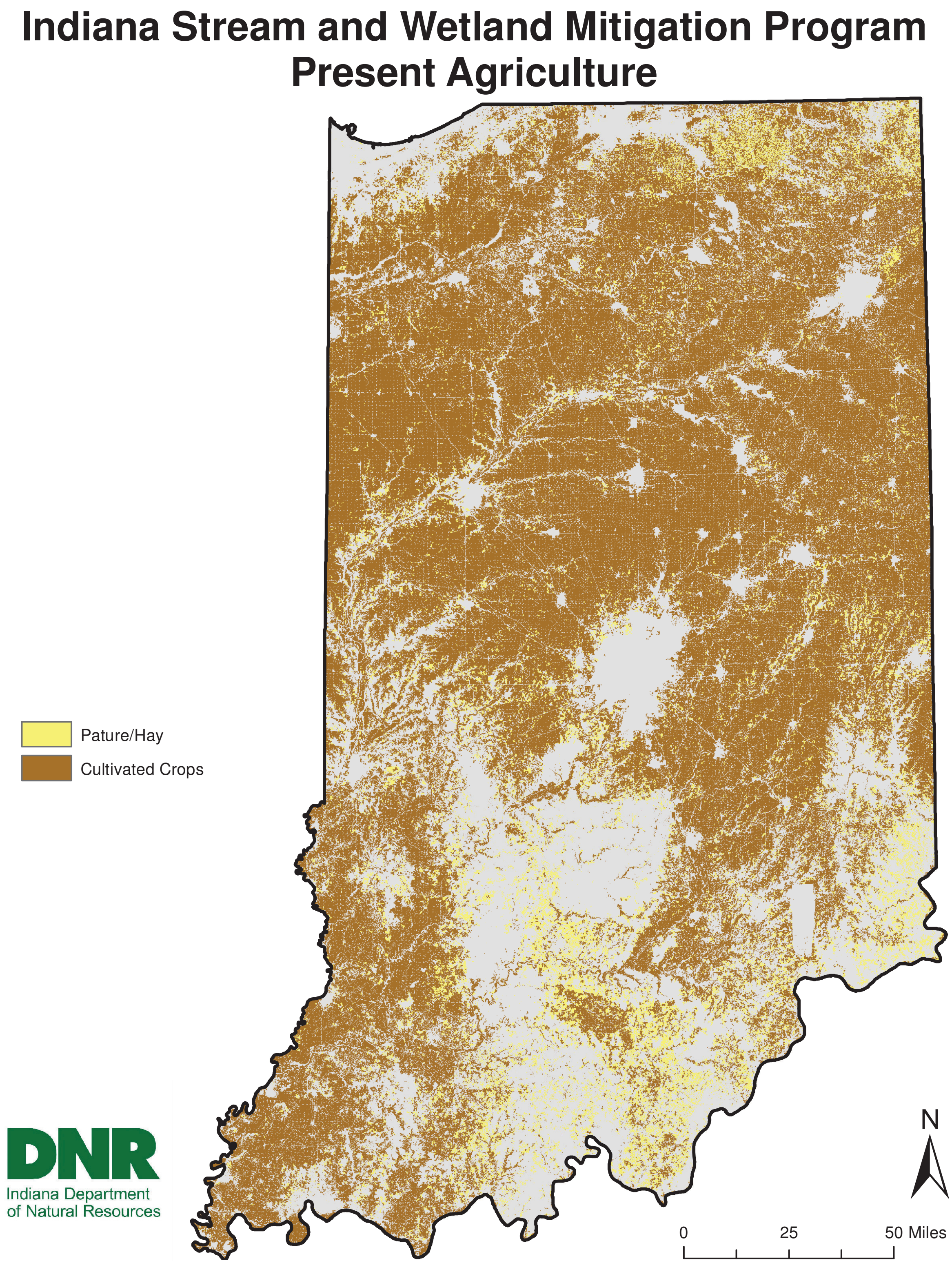

Figure 5. Indiana agricultural land cover; cultivated crops and pasture/hay; 2011 NLCD, (Homer, et al., 2015)

<u>2.2.2 (a) Conversion for Row Crop Production</u>

Indiana has lost approximately 87% of wetlands from pre-settlement, ranking the state as fourth in the United States for acres of wetlands lost (Dahl T. E., 1990). The conversion of wetlands for agricultural production has greatly fragmented and reduced wetland distribution in Indiana.

Although the majority of wetland loss is attributed to early settlement ditching and drainage practices, wetland conversion and manipulation continues to contribute to aquatic resource loss and degradation. Wetlands in Indiana are being lost at a rate of approximately one to three percent each year (Kim, Ritz & Arvin, 2012). Habitat loss associated with stream channelization and wetland conversion to croplands are direct effects of tiling; however, aquatic ecosystems are indirectly affected with increased sediment loads that impair aquatic habitat; elevated phosphorus, nitrogen, and pesticides; and altered volume and timing of runoff due to the hydraulic alterations of these systems (Blann, Anderson, James L., R., & Vondracek, 2009). These tile systems are constructed in patterns to maximize drainage for increased crop yields. This is achieved by controlling inundation frequency and levels by maintaining optimum conditions for planted crops. While manipulated drainage conditions are being maintained, these subsurface tiling systems outlet directly into adjacent streams and impact water quality. Large areas drained by subsurface tile drains in agricultural watersheds generally have higher nitrates, which leads to higher concentrations of nitrate in receiving streams (Blann, Anderson, James L., R., & Vondracek, 2009).

Increased demands and prices for agricultural commodities also contribute to wetland conversion and loss in Indiana. These economic conditions influence the loss of wetlands in Midwestern agricultural areas due to efforts to improve drainage to better support crop production (Dahl T. , 2011). Farm fields are being expanded into wetland areas to increase farmable acres and improve efficiency. Field tile installation in wetland areas is feasible due to the long-term gains in production. Midwestern States, including Indiana, are experiencing wetlands loss due to efforts to improve drainage on agricultural lands as a result of economic conditions (Blann, Anderson, James L., R., & Vondracek, 2009).

In addition to wetland loss and/or conversion, stream manipulations for drainage purposes threaten natural stream systems. Historically, many of Indiana's streams were straightened and channelized in order to increase surface drainage for increased crop production. Maintenance of legal drains continues to be a threat to Indiana's streams. This practice can further degrade the waterway producing negative effects on channel morphology and in-stream habitat for aquatic organisms as well as reducing floodplain and riparian connectivity, altering sediment dynamics and nutrient cycling (Blann, Anderson, James L., R., & Vondracek, 2009). A large proportion of streams in agricultural regions of Indiana are subject to continual maintenance activities. These channelized streams often have their riparian buffers removed to facilitate farming to the top of the stream's bank, resulting in stream instability, increased water temperatures and increased sediment loads. This threatens the aquatic health and habitat of these aquatic systems. In addition, tiles are installed below riparian areas of streams which increase peak and base flows, and contributes to chemical loading (Babbar-Sebens, Barr, Tedesco, & Anderson, 2013). Furthermore, the loss of riparian vegetation disrupts important functions for riverine ecosystems. Riparian areas provide functions for riverine ecosystems by offering an energy source with the input of leaves; provide shading of the stream to maintain more consistent water temperatures for macro invertebrate and fish populations; regulate the growth of macrophytes in streams; and overhanging trees and their roots provide structure and habitat for many types of aquatic life (Vought, Gilles, Fuglsang, & Ruffinoni, 1995). The removal of riparian buffers also fragments important habitats that species rely upon for part of their life-cycle, such as the federally endangered Indiana Bat.

Floodway alterations associated with cropland production disrupt and fragment riparian habitats and their natural processes. The erosion and deposition of sediments from floodplains, along with their depositional patterns and rates, create diverse floodplain wetland communities (King, Twedt, & Wilson, 2006). Levees and non-levee embankment structures are constructed in agricultural areas as an attempt to provide flood protection for crops. These structures are typically constructed parallel to stream systems, restricting the streams ability to have floodway interaction, limiting hydrology needed for wetland formation. Restricted channel migration, due to extensive levee development and channelization, reduces or eliminates the rate of wetland formation; simultaneously, land use alterations that result in increased sedimentation, including channelization and agriculture, accelerate the filling of wetlands (King, Twedt, & Wilson, 2006). This also increase peak flows during rain events and leads to accelerated stream instability. Additionally, restricting floodway interaction also affects soil productivity. Natural productivity of floodplain soils is reduced when rivers become disassociated from their floodplain (Vought, Gilles, Fuglsang, & Ruffinoni, 1995). Cumulatively, these alterations and conversions threaten aquatic habitats and the flora and fauna that are dependent on these natural alluvial processes.

2.2.2(b) Livestock Production

Livestock production and grazing practices also pose a threat to Indiana's aquatic resources and water quality. In order to provide food for livestock, the conversion of natural habitats to hay and pastureland result in the loss and degradation of stream and wetland habitats. Pasture lands that provide livestock direct access to streams can result in riparian loss and geomorphic changes that negatively affect the stream system. The composition of riparian vegetative communities can change due to poor grazing practices, which results in changes in rooting depth, rooting character, surface protection, and aquatic habitat. Moreover, adverse stream channel adjustments such as accelerated bank erosion, increased width/depth ratios, altered channel patterns, induced channel instability, increased sediment supply, decreased sediment transport capacity, and damage fisheries habitats as a result of these changes (Rosgen, 1996). Allowing livestock access to streams has significant implications for streambank erosion. Streambank loss, due to the effect of sloughing from cattle, results in a 77% increase in streambank erosion (Sheffield, Mosaghimi, Vaugh, Collins Jr., & Allen, 1997)

In addition to impacts to riparian areas and stream geomorphic compensation, water quality is negatively affected when livestock have unrestricted access to Indiana's streams. A study conducted on Fishback Creek, located in central Indiana within the Eagle Creek Watershed, revealed that turbidity and ammonium, total Kjeldahl nitrogen, total phosphorus, concentrations of total suspended sediments and E. coli were dramatically affected by unrestricted cattle access to the stream (Vidon, Campbell, & Gray, 2007).

Pastoral land-use can negatively affect natural wetlands, as well. When livestock are not restricted from wetlands they disturb native vegetation, promote compaction and erosion, and excrete their waste directly into the aquatic resource. High levels of fecal contamination in wetlands located in pasturelands without cattle exclusion can transport fecal coliform directly to stream systems during rain events (Vidon, Campbell, & Gray, 2007).

Although the majority of productive agricultural land was gained when early settlers converted and drained a majority of wetlands across the state, there is continued loss of aquatic resources and/or their functions due to the expansion of agriculture and the associated maintenance required for drainage for row crop production in these altered systems which has lasting negative effects on Indiana's aquatic resources. The aggregate of these threats will be a focus for IDNR's IN SWMP. The effects of these impacts to Indiana's waters will be offset with specific goals that will help restore and enhance these aquatic resources.

2.2.2(c) IN SWMP Offsets for Agricultural Impacts:

IDNR's IN SWMP will help offset impacts from agriculture by targeting compensatory mitigation projects, utilizing a watershed approach, which will help improve the quality and quantity of aquatic resources while addressing the unique needs of each service area. Those offsets include:

- Restoring degraded and lost wetland values and services in agriculturally dominant watersheds.
- Restoring channelized streams by replacing natural stream geomorphology and floodway interaction.
- Removing subsurface agricultural drainage tiles in order to restore hydrology to drained wetlands and improve water quality.
- Daylighting subsurface drainage tiles in order to re-establish natural stream and wetland systems.
- Establishing native vegetation on restored streams and wetlands located in agricultural areas while reducing habitat fragmentation.
- Restricting livestock from degrading aquatic habitats, by restoring, buffering and protecting, aquatic resources in watersheds that are dominated by livestock grazing.

Protecting high quality wetlands and stream corridors, providing important aquatic functions and services to the watershed.

2.2.3 Dams, Levees, Floodwalls and Non-Levee Embankments

Dams, levees and non-levee embankments are significant threats to aquatic resources and result in habitat alteration, fragmentation, degradation and loss. The Indiana SWAP recognizes impoundment of water, flow regulation and any associated stream channelization as significant threats to aquatic systems and habitats that require conservation actions (SWAP, 2015).

2.2.3(a) Dams

Dams have been constructed in both developed and rural areas in Indiana for human and livestock water supply, industrial and waste water processes, flood control, irrigation, energy production, recreation, economic development, and historically for grist and lumber mills (ASDSO, 2016). Though dams have a lower percentage of permitted impacts requiring mitigation at this point in time, the cumulative footprint and ongoing secondary impacts to water quality, fish, wildlife, and botanical resources are significant. The USFWS recognizes that free-flowing rivers are vital to our nation's aquatic species, and native fish, shellfish, amphibians, waterfowl and plants that depend upon the natural flow variations of rivers at many stages of their lives (USFWS, 2012).

Continuing threats due to dams include, but are not limited to structural integrity and dam failure, diminishing natural system functions and services, reservoir sedimentation and accumulation of contaminants, channel degradation, inundation of critical riverine habitat, flow alteration, a multitude of negative water quality effects, increases in invasive, alien and tolerant species, blockage of fish passage and migrations, hydraulic undertows (rollers), and socioeconomic and cultural effects (services) (Aadland, 2010).

Dams alter two critical elements of a fluvial system: the ability of a river to transport sediment and the amount of sediment available for transport (Grant, Schmidt, & Lewis, 2003). Dams alter the ability of a stream or river to transport a natural sediment load, often causing a downstream sediment deficit that triggers accelerated stream bed and bank degredation, incision, change of bed material distribution, and changes in channel deminsions (Grant, Schmidt, & Lewis, 2003). Dams also obstruct the migration of fish to spawning or feeding areas, fragment and alter physical habitats, and negatively affect species distriubtions within riverine systems (Liermann, Nilsson, Robertson, & NG, 2012).

According to the American Society of Civil Engineers (ASCE), the average age of the approximately 84,000 dams in the U.S. is 55 years old, and dams receive an overall grade of poor (D+) on the *2013 Report Card for America's Infrastructure* (ASCE, 2013). Indiana's dams share the same overall grade, with 57 percent of dams considered conditionally poor or worse due to age, deterioration and/or a lack of maintenance (ASCE, 2013). Though the time of prolific dam construction is in the past, DNR dam records show that the majority of dams are nearing 40 to 60 years in age, with some structures more than 100 years old (IDNR DOW, 2016).

Dams in Indiana are classified as high, significant or low hazard based on the threat they present to downstream property and life upon failure. This classification, however, does not consider the existing structural integrity of the dam, its likelihood of failure and/or the ecological impacts. The ownership type and hazard distribution of currently known regulated dams are shown in **Table 3**, and the statewide distribution of dams is illustrated in **Figure 6**.

Owner Type	High Hazard	Significant Hazard	Low Hazard	Totals
Federal Government	8	1	9	18
State Government	16	27	85	128
Local Government	30	28	86	144
Public Utility	15	13	18	46
Private and/or Unknown	183	213	522	918
Totals	252	282	720	1,254

Table 3. Indiana approximate dam totals and ownership type, (IDNR DOW, 2016)

Approximately 70% of the known regulated dams are in private ownership. These private dams may pose greater downstream ecological risk given that the costs associated with dam maintenance, rehabilitation and/or reconstruction are often prohibitive for typical private owners (IDNR DOW, 2016). Ecological effects due to dam failure can include intense flooding and overbank destruction of vegetation; hydraulic damage such as erosion, channel incision and sedimentation; and sediment inundation of critical habitat and damage to fisheries (Evans, Mackey, Gottgens, & Gill, 2000). Additionally, dam failure can result in damage of infrastructure and utilities, futher compounding the negative chemical, physical and biological impacts to aquatic resources and dependent habitats.

Though significant and high hazard dams receive the most regulatory and funding attention (public and/or private), until recent history, the majority of low head dams have not since they are given a low hazard classification due to minimal downstream risk to life and property upon failure. This classification does not address the ecological impacts associated with the dams' presence in the watershed or the potential for ecological harm should they fail. There are 175 currently known low head dams in Indiana (**Figure 7**). Analysis of the IDNR, Division of Water, *Low Hazard In-Channel Dam Visual Inspection Reports* (IDNR DOW, 2016) and the *Indiana Silver Jackets* (ISJ) low head dam statewide inventory, indicates at least 40 percent of currently known in-channel low head dams do not serve the purpose for which they were constructed. The ownership of approximately 35 percent of existing low head dams is unknown, and approximately 50 percent of low head dams are reported to have a poor (deteriorated) overall condition.

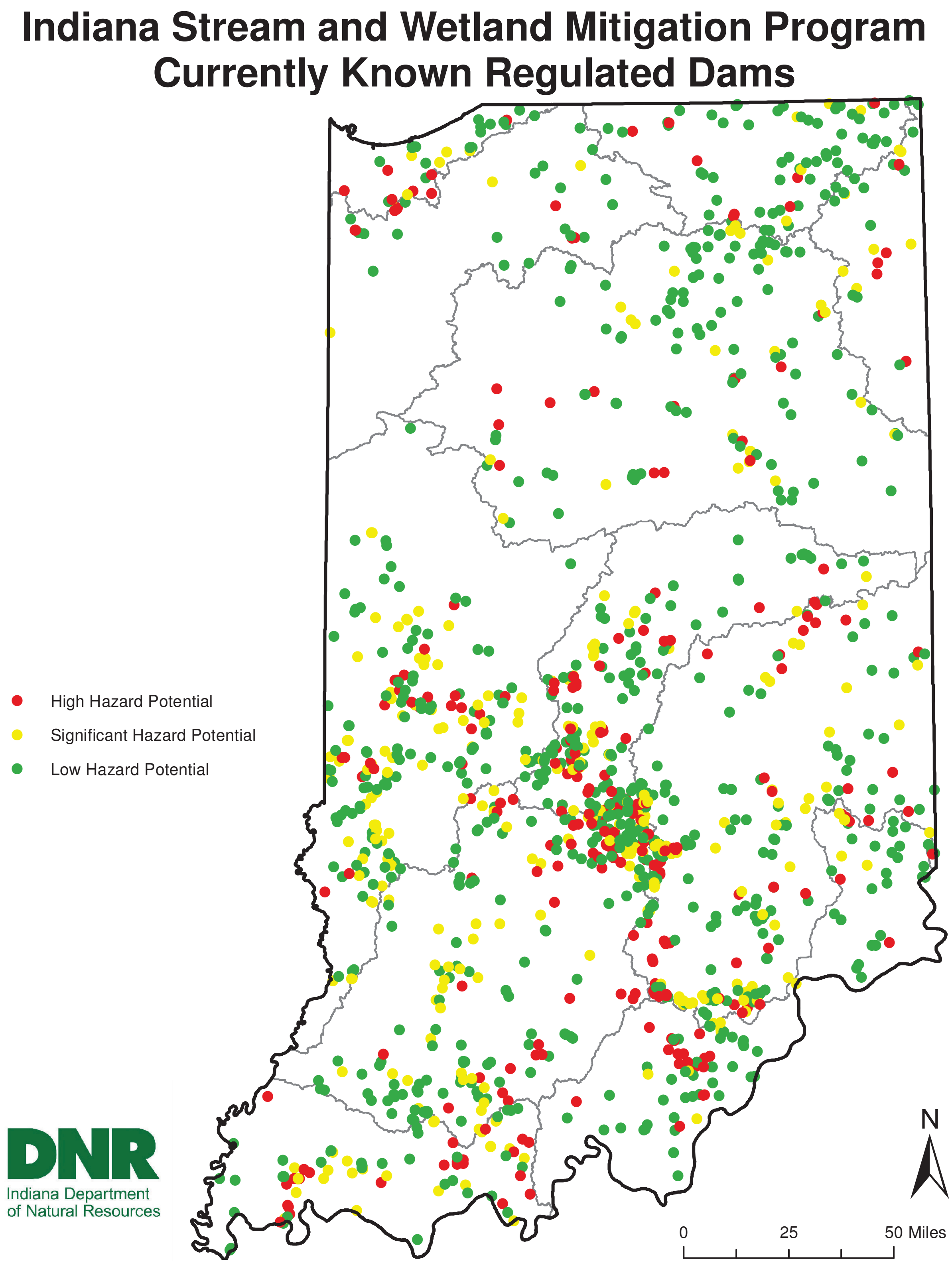

Figure 6. Dams currently regulated by IDNR, (IDNR DOW, 2016)

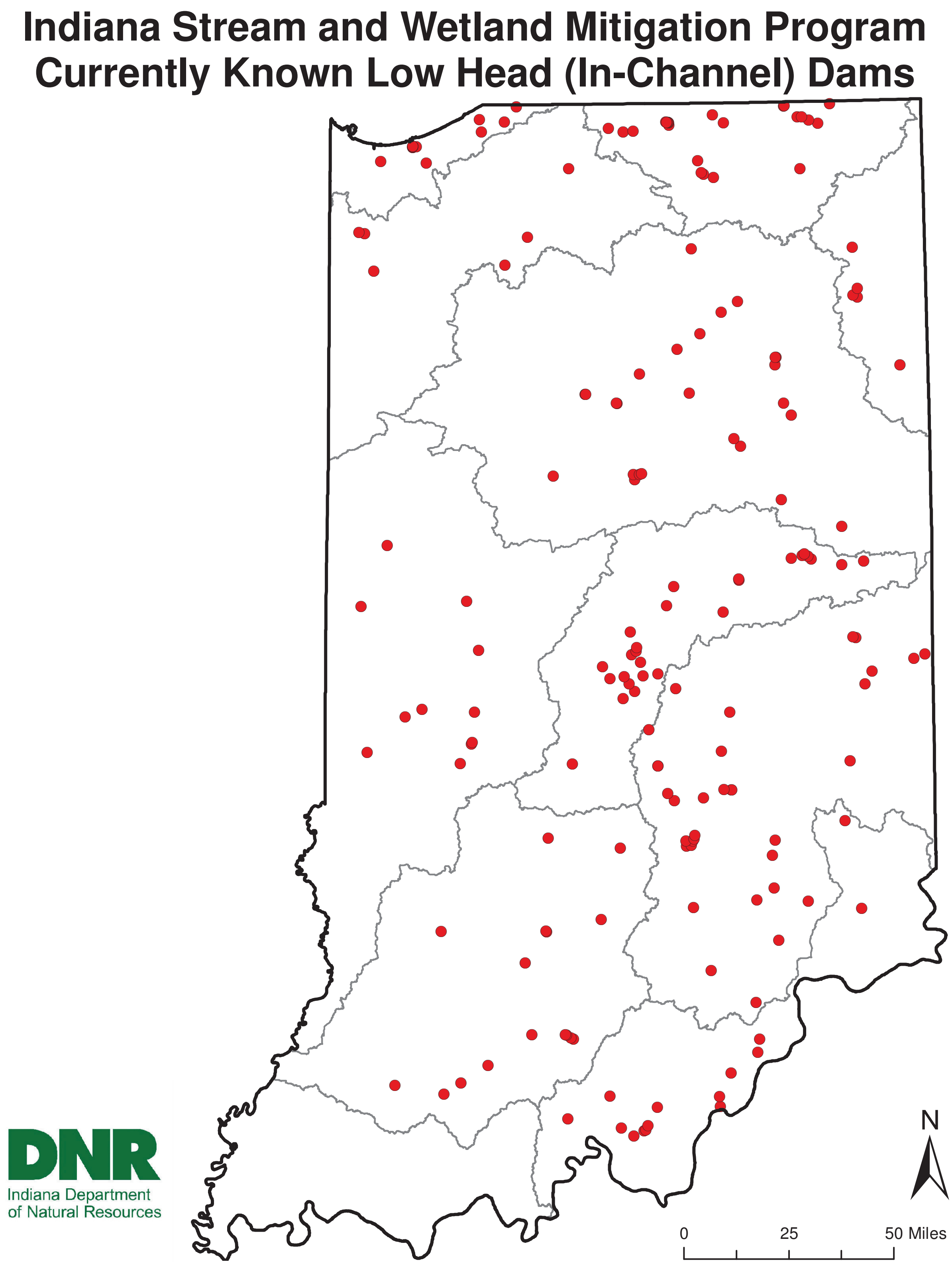

Figure 7. Identified low-head (in-channel) dams in Indiana, (IDNR DOW, 2016)

Due to the known adverse effects of low head dams to aquatic resource functions and services, there has been an increased interest in removing and/or modifying these structures in Indiana to increase aquatic resource functions and/or services within watersheds.

The DNR Division of Fish and Wildlife Aquatic Habitat Unit has ranked low head dams in order of priority for modification or removal using GIS Digital Elevation Models (Lidar), the National Hydrography Dataset, and DFW Game and Non-Game Fisheries Biologists' surveys based on the following physical and biological parameters, and distributed in quartiles per service area below (**Table 4**):

- Inundated pool length (natural channel recovery potential)
- Upstream reconnection reach including perennial tributaries
- Impacts on mussels
- Impacts on non-game fishery
- Impacts on sport fishery
- Aquatic invasive species accessibility
- Conservation Partner priority areas
- State navigable or outstanding river

Service Areas	Low Head Dams	Bottom Quartile	Second Quartile	Third Quartile	Top Quartile
Calumet-Dunes	13	10	1	2	0
Kankakee	6	4	0	1	1
Lower White	16	5	7	2	2
Maumee	5	1	2	1	1
Middle Wabash	11	3	3	3	2
Ohio-Wabash	0	0	0	0	0
St. Joseph	24	1	7	3	13
Upper Ohio	15	1	6	6	2
Upper Wabash	25	3	6	9	7
Upper White	26	9	3	9	5
Whitewater-East Fork White	34	10	9	8	7
Statewide	175	47	44	44	40

Table 4. Quartile ranking of DNR Division of Fish and Wildlife low head dam removal priority per IN SWMP Service Area. IDNR Division of Fish and Wildlife, Aquatic Habitat Unit

Though this IDNR Division of Fish and Wildlife priority ranking was conducted specifically as an assessment of a dam removal's impact to aquatic species, any of these physical and biological factors can be assessed in conjunction with broader stream and/or watershed parameter considerations in order to pursue the most gain in aquatic functions and services. Based on this analysis, there are approximately 22,134 miles of potential perennial channel reconnectivity, and 149 miles of recoverable channel within existing dam pool lengths when considering the cumulative footprint of all 175 known low head dams.

Removal of dams can restore natural flow regimes, improve water quality, restore natural sediment transport and bedload, and restore connectivity for fish and other aquatic organisms promoting the rehabilitation of native species (American Rivers, 2002). All of the above improvements of fluvial system functions and services have recently been demonstrated with the removal of three low head dams within the Eel River in north central Indiana by the efforts of Manchester University with support from the USFWS National Fish Habitat Program. Robust pre and post dam removal monitoring has shown thus far that built up sediment behind the dams has been transported, natural morphology has been restored, QHEI scores have increased by 20 percent upstream of each dam, IBI scores improved from a “Fair/Poor” status to “Good” (USFWS, 2014), and in conjunction with a fish passage project at another dam within the Eel River, the projects have the cumulative potential of 728 perennial stream miles restored for aquatic life migration and connectivity (IWRA, 2015).

2.2.3(b) Levees, Floodwalls and Non-Levee Embankments

Levees, floodwalls and non-levee embankments have been and continue to be constructed, maintained and upgraded in urban and rural settings to contain, control, and/or divert the flow of flood waters in order to reduce risk of threat to life, property and/or agriculture. Levees constructed in urban areas are more likely to be built to higher standards, such as those certified by the USACE, than those in rural areas. Some levee systems accredited by the FEMA National Flood Insurance Program show a 1-percent annual-chance flood risk reduction on respective Flood Insurance Rate Maps (FIRM). Non-levee embankments, which are not Corps certified and/or FEMA accredited levees, tend to be in rural agricultural settings, or related to road or rail transporation routes, and are not designed or constructed to engineering standards of structural integrity or freeboard of the 1-percent chance flood or greater (FEMA, 2016).

Ongoing threats due to levees, floodwalls and non-levee embankments include, but are not limited to: adverse impacts to natural functions and services of a riverine system; the displacement of floodwaters to adjacent, upstream or downstream properties; increased flood frequency and severity; increased depth and velocity of floodwaters; alteration of the natural attenuation of flows; increased channel incision, bank erosion and sedimentation; alteration and/or removal of channel and floodplain interaction; and removal of riparian vegetation, wetland hydrology and critical habitat (ASFPM, 2007).

The USACE maintains the National Levee Database (NLD), which contains reports and locations of the majority of levees within the USACE Levee Program (USACE, 2016), but this dataset only accounts for an estimated 15% of the total levees nationwide (National Committee on Levee Safety, 2016). The National Committee on Levee Safety estimates that the locations of 85% of the nation’s levees are unknown. There is currently no holistic national inventory of levees, and there is not a single centralized data host of levee inventories (National Committee on Levee Safety, 2016). FEMA does not currently maintain a publically available database for the locations for FEMA accredited levees, though they can be identified on respective FIRMs. In response to the 2008 natural disasters that resulted in

Presidential Disaster Declarations for 82 of Indiana's 92 counties (IN OCRA & IHCDA, 2009), a Non-Levee Embankment (NLE) mapping project was conducted as a joint effort between the IDNR Division of Water, Indiana Silver Jackets, The Polis Center, Indianapolis Mapping and Geographic Infrastructure System IMAGIS/Indy GIS, and Southern Illinois University Geography (IDNR, 2016).

The purpose of the project was to identify and map NLE's utilizing LiDAR and other advanced geoprocessing techniques (**Figure 8**). NLE's are elevated linear features adjacent to waterways and within the floodplain typically related to agriculture (flood protection for farm fields) or transportation (elevated road and rail). NLE's located in floodplains have an effect on the movement and expansion of waterways increasing the potential flood risk, and often have a dramatic impact on flood conveyance and flood heights by detaining or directing flood waters. By identifying these features, Indiana can assess and mitigate for the potentially detrimental effects resulting from reduced storage capacity and increased downstream flooding. Only 82 of the 92 counties in the Indiana were eligible for inclusion in the mapping effort. IDNR's goal is to secure funding to map NLE in the remaining 10 counties to complete the statewide dataset. The resources provided by this project enable the private and public sectors to better recognize these embankments and adopt strategies to mitigate NLE related risks and adverse impacts to aquatic resources, life and property (IDNR, 2016).

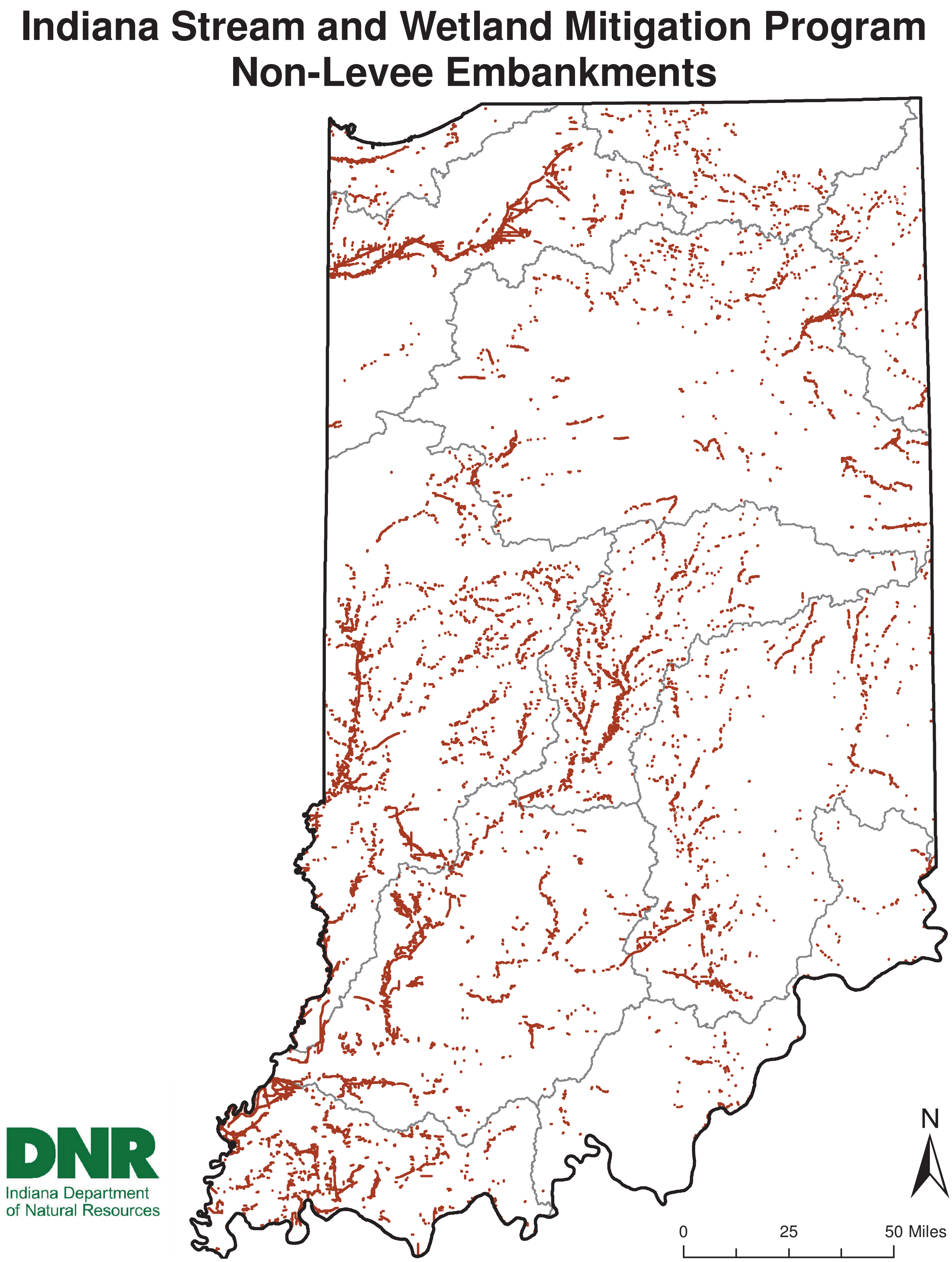

Figure 8. GIS analysis to identify non-levee embankments (completed in 82 of 92 counties), (IDNR, 2016)

2.2.3(c) IN SWMP offsets for threats posed by dams, levees and non-levee embankments:

IDNR's IN SWMP will help offset impacts from dams, levees, and non-levee embankments by targeting compensatory mitigation projects, utilizing a watershed approach, in which will help improve the quality, quantity, and functions and services of aquatic resources while addressing the unique needs of each service area. Those offsets include:

- Remove high and low head dams prioritized for removal and conduct in-stream restoration that would help improve the ecological health of the stream by providing an increase in natural functions and services, upstream connectivity, improved water quality, and increased aquatic and/or riparian habitat.
- Modify low head dams that are not eligible for removal in conjunction with broader aquatic resource restoration measures that will help improve natural stream functions, services, water quality, and upstream connectivity.
- Identify and restore degraded stream channels, riparian areas and/or wetlands upstream of impounded waters including public freshwater lakes to address system specific causes of impairment using appropriate functional assessment methodologies and restoration techniques to help improve natural functions and services while contributing to improved water quality and reduced sedimentation of the impounded water.
- Identify and restore wetlands contiguous with public freshwater lakes, public reservoirs or water supply reservoirs that will contribute to improvement of the functions, services, water quality and habitat of the water body and downstream receiving waters.
- Identify non-levee embankments for removal or breach to help reestablish channel and floodplain connectivity, improve degraded channel morphology, and conduct riparian and/or wetland restoration measures to address system specific symptoms caused by the structures.
- Identify degraded channels downstream of dams which are not eligible for removal or modification to address system specific symptoms caused by the dam that have potential for restoration of the natural stream channel and riparian habitats to help influence the system's natural fluvial processes to adjust and function within the existing hydrologic conditions downstream of these dams.

2.2.4 Energy Production and Mining

Indiana is influenced by the reserves of natural resources it contains. Its natural deposits provide energy resources resulting in industries that extract and produce commodities for the national and global scale, as well as supports industries that facilitate and utilize these resources. The state has reserves of coal, oil, natural gas and industrial minerals, which includes clay, shale, limestone, gypsum, sand and gravel. All of these resource deposits support Indiana's mining and aggregates industry. Mining extraction processes require extensive land disturbance, resulting in ecological impacts that threaten the current and long-term health of Indiana's aquatic environment.

2.2.4(a) Coal

Indiana's coal producing region is located in 25 southwestern counties, occupying approximately 6,500 square miles. In 2014, Indiana was ranked the eighth greatest coal-producing state in the country and its surface and underground coal mines produce approximately 39 million tons of coal annually (U.S. Department of Energy, 2014). Coal produced in southwestern Indiana is extracted from the Indiana Coal Field. This geologic formation comprises the eastern portion of the greater Illinois Basin, see illustrated in **Figure 9** below.

Although coal reserves have been mined in this region for over 150 years, the area retains substantial reserves. It's estimated that Indiana has enough coal reserves to supply energy for the next 300 years (Modisett Kemp, 2012). Energy consumption in this region is influenced by proximity and feasibility of the regional coal reserves. Indiana coal consumption is estimated to be 1,200 Trillion BTU per year, which ranks third nationally (U.S. Department of Energy, 2014). With established coal mines and miners in the Indiana coalfield region, and with its ample reserves, surface and underground mining will continue to shape the region's landscape. Until feasible energy alternatives become viable sources for energy, the utilization of coal for industry and energy production will continue to be utilized in Indiana.

According to IN SWMP's analysis of permitted impacts authorized under Section 404 of the Clean Water Act between 2009 and 2015, coal mining projects comprised 81.76% of stream and 78.58% of wetland permitted impacts statewide that required compensatory mitigation. Surface and underground coal mining are the primary mining methods used in coal recovery in southwestern Indiana. Although both mining techniques are actively used, surface mining is the dominant coal mining method, with 98% percent of permitted actions from 2009-2015, resulting in compensatory mitigation.

Both mining methods require surface land disturbances resulting in impacts to aquatic resources. Surface coal mines generally result in greater impacts due to the mining method. Surface mines require larger mining boundaries, where vegetation, top soil, then substantial amounts of rocks and overburden is removed in order to extract the coal (Greb, Eble, Peters, & Papp, 2006). During this process, all unavoidable surface waters within the mining footprint are filled or mined through, impacting all surface water features.

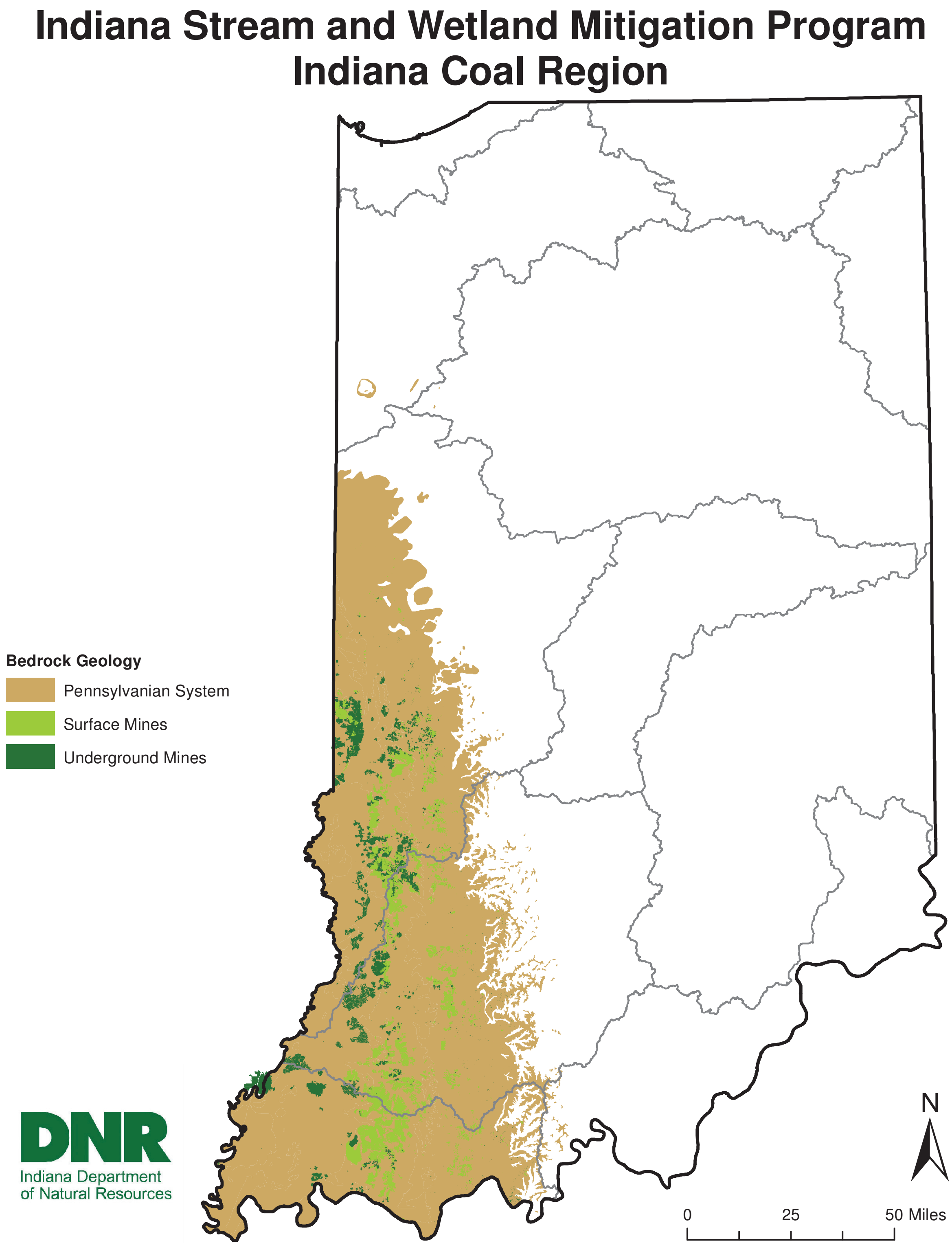

Figure 9. Illinois basin coal field within Indiana

In contrast, underground mines generally require smaller, more concentrated physical disturbances associated with mine access areas (Greb, Eble, Peters, & Papp, 2006). Although the surface footprint is generally smaller with underground mines, surface aquatic resources are often negatively impacted. Underground mines utilize conveyer systems in order to transport mined coal and resulting mine refuse (Greb, Eble, Peters, & Papp, 2006). Once these materials are conveyed to the surface, the processing of recovered coal and resulting refuse require areas for disposal within the mining boundary. This generally results in impacts to aquatic resources within the surface boundary of the underground mining operation.

All active coal mines in Indiana are subject to regulatory requirements when those activities result in impacts to aquatic resources. Sections 404 and 401 of the Clean Water Act of 1972 (CWA) requires compensatory mitigation for permanent impacts to jurisdictional streams, wetlands and lakes resulting from the placement of fill and/or the complete loss of these aquatic resources due to mining-related activities. In addition, the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) requires active mining operations to reclaim the physical disturbances to the landscape during and following the mining process (U.S. Department of Interior, 2016)

Although active coal mining operations must adhere to current regulatory requirements, prior to SMCRA, mining operations were not required to reclaim mined areas. Pre-SMCRA, coal production was the primary objective and minimal reclamation measures were implemented by mining companies resulting in severe and long lasting environmental consequences (Stevens, 2012).

In response to the environmentally adverse effects of abandoned mine lands, the passage of SMCRA established the Abandoned Mine Lands (AML) program to address environmental degradation associated with past coal mining practices with funding coming from a per-ton tax on coal assessed to coal operators (Stevens, 2012). Although AML projects continue to address the lasting environmental degradation of abandoned mines, it is estimated that Indiana contains a large amount of pre-SMRCA mine lands that still require reclamation. The Indiana Department of Natural Resources-AML Program has approximately $194 million worth of reclamation projects in the current program inventory which covers approximately 3,500 acres throughout 16 counties in southwestern Indiana; however, there is a considerable amount of AML eligible lands that will be inventoried in the future (Stacy, 2016). With multiple program objectives and limited funding for AML projects, the legacy of degradation of AML sites will continue to pollute and depress watersheds, and their aquatic systems, throughout the coal bearing counties (Weber, 2012).

Acid mine drainage (AMD) continues to be a concern for Indiana’s wetlands and streams as acidic waters resulting from coal mining leach into the groundwater and downstream surface waters, degrading water quality and preventing the establishment and longevity of aquatic fauna and flora (Amlaner & Jackson, Habitats and Ecological Communities of Indiana: Presettlement to Present, 2012).

AMD is a persistent problem associated with abandoned coal mines because of its negative effects on Indiana's streams, wetlands, lakes, and even entire watersheds (Weber, 2012). In the process of extracting coal, mining and coal processing results in waste material, such as spoil, slurry, and gob. This waste material results in AMD if not reclaimed and has lasting effects to the aquatic environment.

2.2.4(b) Natural Gas and Oil Production

Indiana contains over 13 million acres of oil and natural gas reserves. Indiana ranks in the top 25 for oil and gas production. According to the U. S. Energy Information Administration data, natural gas marketed production totaled 7,250 million cubic feet for 2015; while crude oil production totaled 158 thousand barrels through August 2016, ranking Indiana 24th in both categories nationally (U.S. Department of Energy, 2016). **Figure 10**, provides the statewide distribution of Indiana oil and gas petroleum fields.

The physical alterations associated with the exploration, development, production, recovery and delivery of petroleum products from Indiana's oil and gas fields pose threats to Indiana's aquatic resources. Aquatic habitats are threatened by landscape changes, related to pad development and associated infrastructure, including new and expanded roads, pipelines, compressor stations, and impoundments (Brittingham, Maloney, Farag, Harper, & Brown, 2014). Changes in hydrology, sedimentation, and water quality in response to oil and gas development have been identified as three main stressors to surface waters based on recent studies (Brittingham, Maloney, Farag, Harper, & Brown, 2014). These alterations have compounding effects that expand beyond the footprint of these fields. Habitat loss, wildlife mortality and displacement, and introduction of invasive species result from oil and gas impacts to wildlife and the environment (Ramirez Jr. & Mosley, 2015). In addition, the operation and development of petroleum fields can result in contamination of aquatic resources. Significant environmental impacts and injury to fish, wildlife and their habitats due to oil and gas operation and maintenance activities can occur from accidental releases and spills, brine, and/or chronic leaks in aging infrastructure (Ramirez Jr. & Mosley, 2015). These sources of contamination can negatively affect both surface water and groundwater.

2.2.4(c). Mineral and Aggregate Mining

The Indiana mineral mining industry produces commodities such as crushed stone and dimension stone, which generally have prolonged periods of mining, as well as shale, clay gravel, gypsum, marl and peat (Shaffer, 2012). Some of these commodities have made Indiana a mining leader based upon production. For example, Indiana contains the largest brick facility in the United States which mines Indiana shale to make 120 million bricks per year. Indiana is also a leading producer of dimension limestone (U.S. Department of Interior, May 2015).

Indiana Stream and Wetland Mitigation Program
Petroleum Fields and Wells

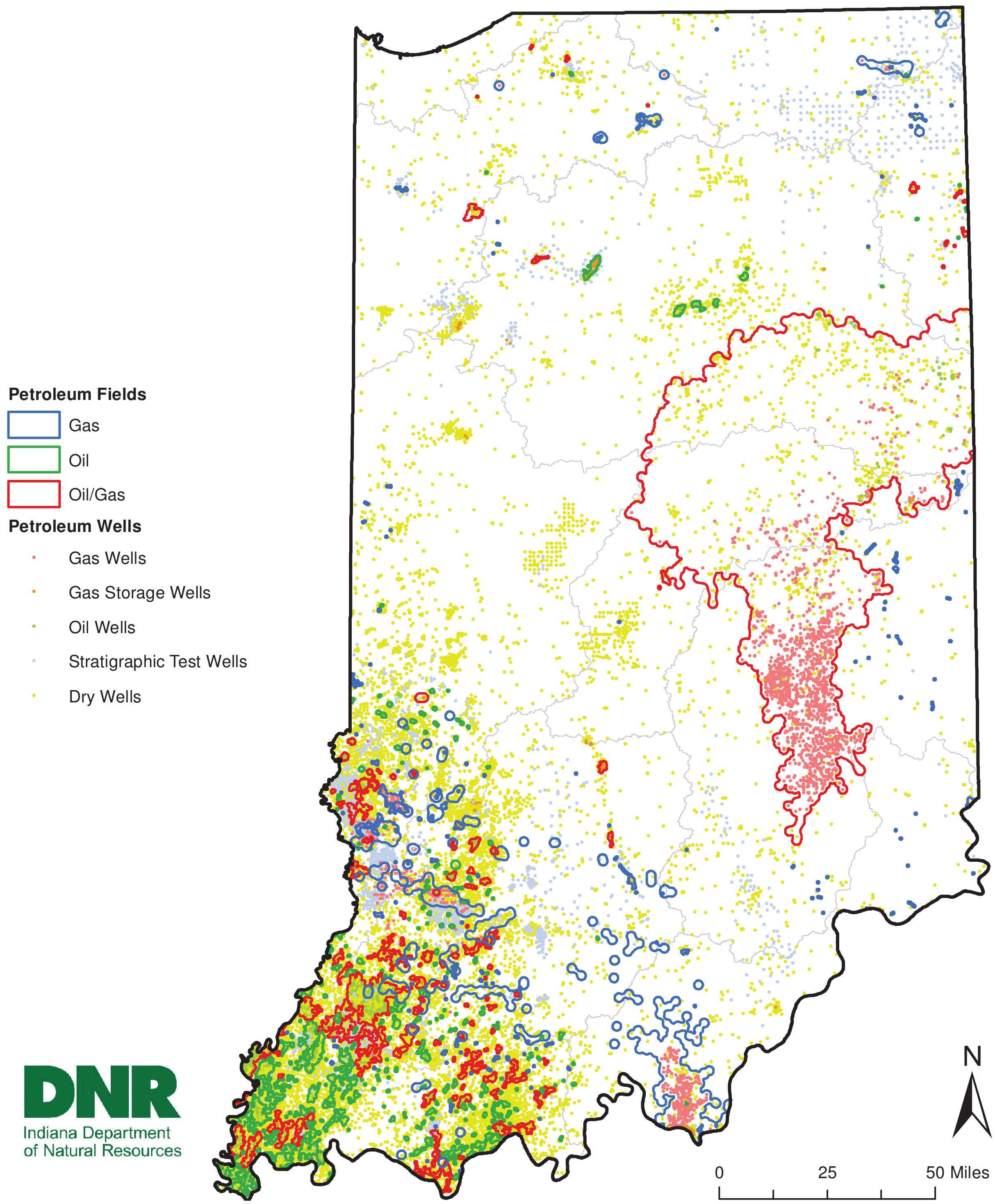

Figure 10. Indiana Oil and Gas Petroleum Fields Map

Although mineral mining's footprint is relatively small when compared to Indiana's coal production, they have similar impacts to aquatic resources. Mineral mine distribution is more widespread across the state than coal mining, which means that the threats to aquatic resources are seen more widely across the state and affect all of the IN SWMP service areas.

Changes in geomorphology and conversion of land use, accompanied by habitat loss, noise, fugitive dust, vibrations, chemical spills, erosion, and sedimentation are associated with quarry impacts (Langer, 2001). Demand for new construction and infrastructure provide the catalyst for aggregates which perpetuates impacts to aquatic resources throughout Indiana. Surface waters are threatened by these activities because mineral mining can intercept surface waters, changing their course; additionally, groundwater pumping from quarries effects streams and nearby surface water features such as wetlands by altering their hydrology. Lastly, water discharges from quarries can result in increased flood recurrence intervals when discharged directly into nearby streams (Langer, 2001).

All mined resources result in impacts to the environment; however, some mineral resources can result in more damaging effects to the aquatic environment based on the deposits' proximity to aquatic resources. One of the top sources of sand and gravel aggregate materials are found in alluvial deposits such as stream channels and terraces, flood plains and alluvial plains (West & Cho, 2006). This is shown in **Figure 11**, which maps the locations of the majority of sand and gravel mine operations being within alluvial deposits. Streams and adjacent wetlands are threatened by aggregate extraction in sensitive areas.

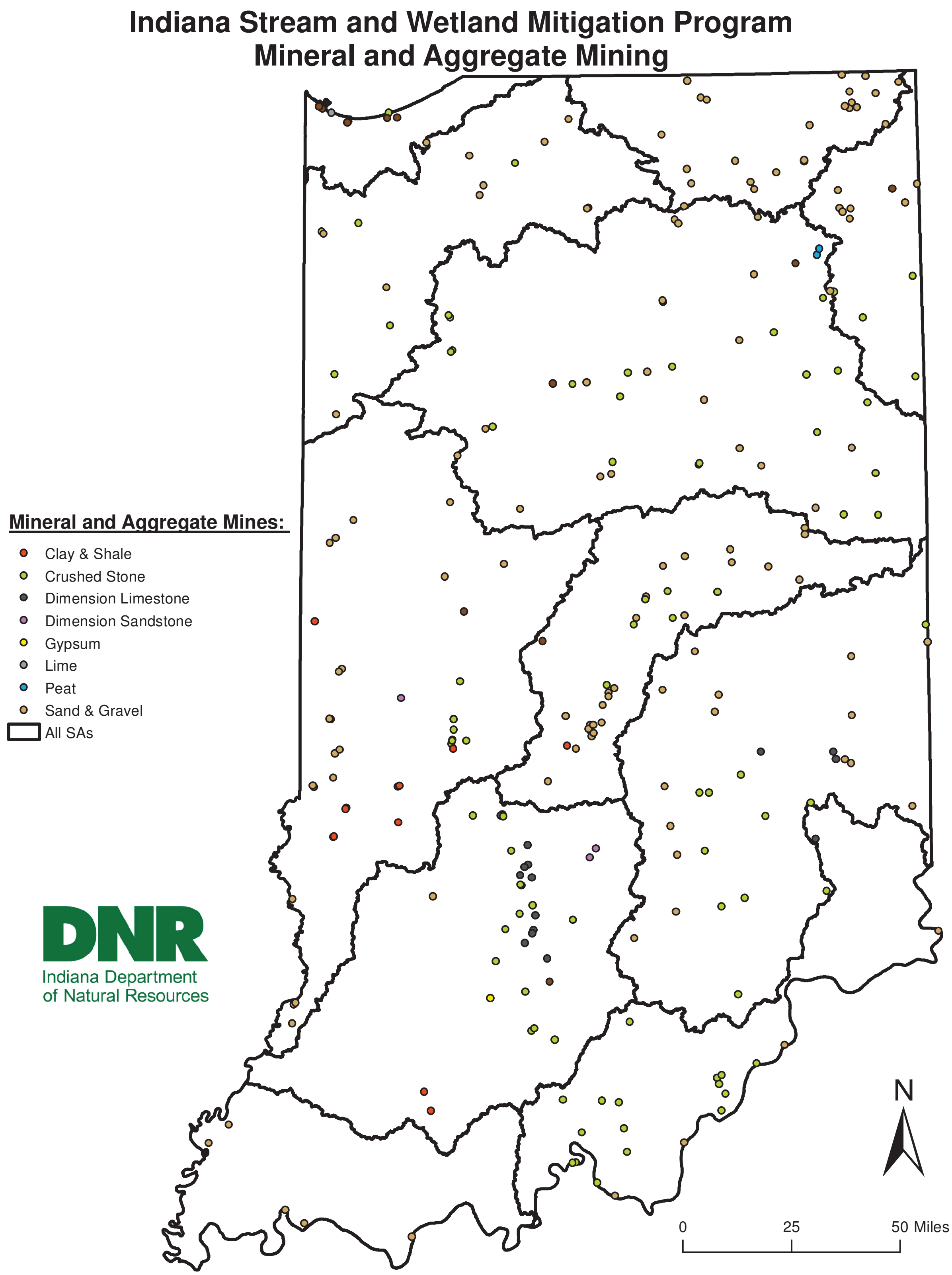

Figure 11. Indiana mineral mining statewide distribution

2.2.4(d) IN SWMP Offsets for Energy Production and Mining Impacts:
IDNR's IN SWMP will help offset impacts from energy production and mining by targeting compensatory mitigation projects, utilizing a watershed approach, which will improve the quality and quantity of aquatic resources while addressing the unique needs of each service area. Those offsets include:

- Implement stream and/or wetland restoration projects that supplement IDNR Division of Reclamation's Abandoned Mine Lands Program reclamation projects that will help increase Indiana's aquatic resource functions and services.
- Restore fluvial processes by implementing natural stream restoration projects on streams that have experienced physical degradation from mining, natural gas and oil production activities.
- Implement mitigation projects that connect fragmented habitats that are a result of cumulative effects associated with historic and ongoing mining activities and natural gas and oil production.
- Preserve and enhance high quality wetlands and stream corridors that provide important aquatic functions and services to the watershed that are directly threatened by impacts from mining, natural gas and oil production activities.

2.2.5 Transportation and Service Corridors
Transportation is an integral component to providing national and local mobility, which is necessary for economic vitality and quality of life. Transportation supports Indiana commerce, such as manufacturing, wholesale, and agribusiness, by providing networks for the mobilization of raw materials, produce and finished products (Indiana Department of Transportation, 2015).

2.2.5(a) Roadways
Construction of new roadways and improvements to existing roads can result in negative effects on aquatic resources. The major ecological impacts of road networks (**Figure 12**) at the landscape scale are the loss of bio diversity and disruption of landscape processes; at the local scale, aquatic resources suffer ecological effects due to roadways.

Aquatic and terrestrial ecosystems are affected by roads due to physical alteration of the environment, modified animal behavior, increased mortality from road construction and collision with vehicular traffic, alteration of the chemical environment, and spread of invasive species (Trombulak & Frissell, 2000).

Long-term effects to aquatic resources threaten stream and wetland health, along with the biological communities that depend upon these ecosystems. Road and bridge construction can alter the natural development of stream channels, floodplains, and wetlands. The physical effects of road incursion may extend long distances from the construction site due to the energy associated with moving water; in addition, changes in channels and shorelines many miles away, both up- and down-gradient of a road crossing, are a response to the effective changes in hydrodynamics and sediment deposition (Trombulak & Frissell, 2000).

The most common characteristic of human impacts in riverine systems is associated with alterations to connectivity of the fluvial system (Wohl, 2004) (Blanton & Marcus, 2009). Many roads are constructed along river valleys and intercept rivers and streams. Roads require bridges and culverts as they cross aquatic features. Road placement and stream crossings result in connectivity alterations that fragment riverine systems and processes. These disruptions can have profound impacts to natural stream processes. Fluvial system impacts alter a stream’s ability to interact with the river landscape by disrupting the ability to exchange water, sediment and biota, which control the evolution of stream channel and floodplain habitat (Blanton & Marcus, 2009).

Indiana Stream and Wetland Mitigation Program
Interstates, Highways and Railroads

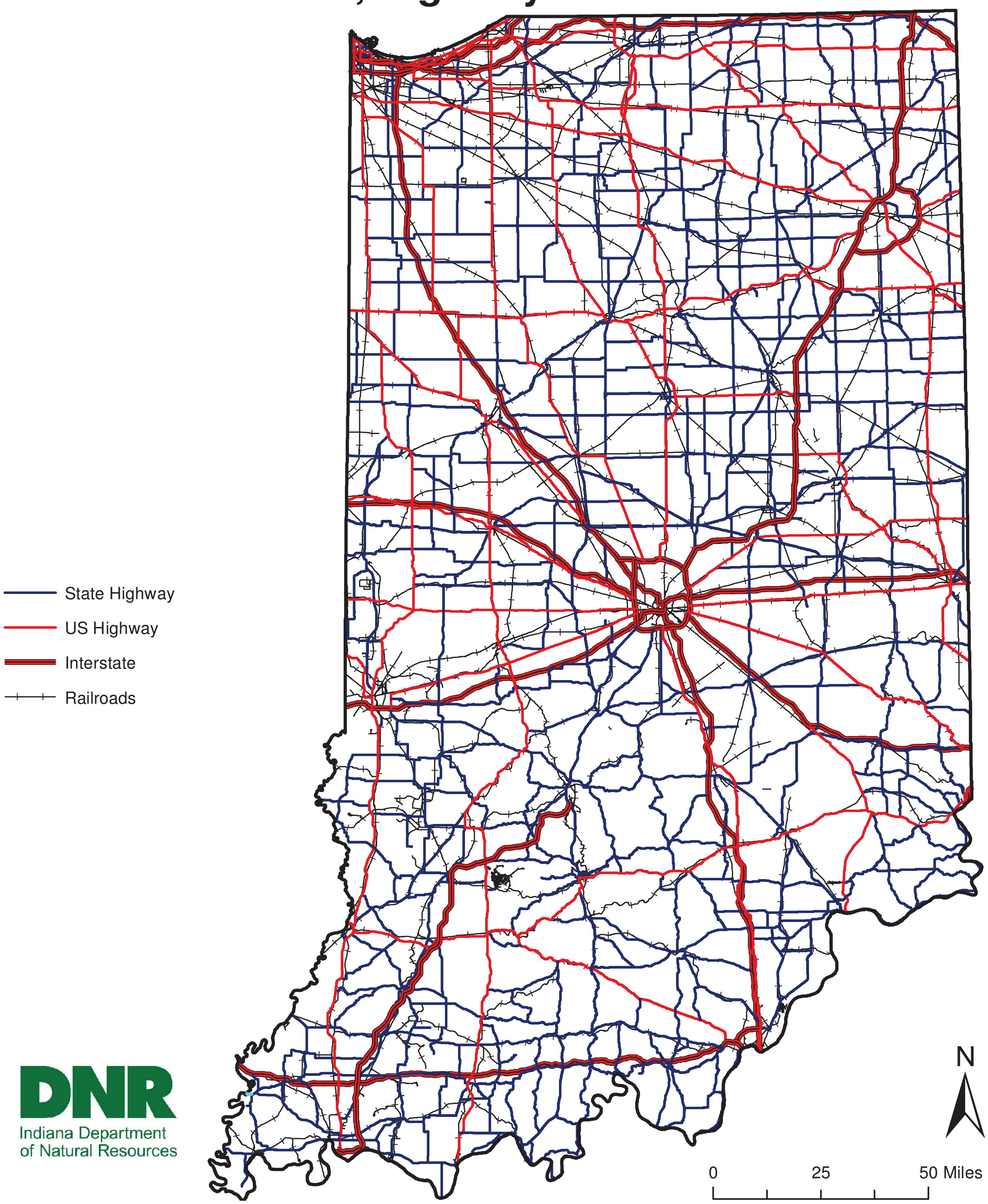

Figure 12. Indiana Railroads and Roadways. (INDOT Road Inventory Section, 2016); (Federal Railroad Administration, 2002)

In addition to disruptions to fluvial processes, transportation networks create barriers that directly impact aquatic community health. Valley-bottom roads can destroy or block access to seasonal floodplain wetlands and small tributaries, that salmonids and riverine fishes seasonally escape stresses of main channel flows; even more, the distribution and productivity of a population can be reduced due to persistent barriers that encourage local selection for behaviors in response to the limitation of natural migration patterns (Trombulak & Frissell, 2000). River and stream crossings can compound long-term negative affects to aquatic communities. Fishes and other aquatic animals are commonly restricted by road crossings that act as barriers (Trombulak & Frissell, 2000). Inadequate culverts disrupt aquatic organism movement, which threatens the overall population health of these aquatic species.

Although efforts are in place to address aquatic passage issues, many existing stream crossings were installed without these considerations. This has resulted in issues that impact aquatic communities and the ecosystem processes they depend upon, such as natural hydrology, sediment transport, fish and wildlife passage, or the movement of woody debris (Jackson, Bowden, & Graber, 2007).

Wildlife populations are affected by habitat fragmentation of natural areas into smaller remnants, reducing the number of species able to move from one area to another (Andrews, 1990). This is especially true for aquatic ecosystems and their associated fauna. Wetland species, including amphibians and turtles, commonly show reduced tendencies to cross roads, creating a barrier effect when moving to adjacent habitats (Forman & Alexander, 1998). In addition, roads create edge effects that promote long-term consequences that extend beyond initial impacts during construction; including altering the physical characteristics of soil density, temperature, soil water content, light, dust, surface-water flow, runoff patterns, and sediments (Trombulak & Frissell, 2000).

When considering a roadway's proximity to aquatic habitats, wetland species can be subject to road mortality impacts. This relationship can result in increased threats for sensitive species. A study was performed in Tippecanoe County, Indiana that involved a multi-species road-kill survey to determine a correlation between roadways and impacted species' habitat characteristics. While developing a species index focused on herpetofauna specific to Indiana, they evaluated landscape characteristics of roads that experienced high vertebrate mortality and associated effects of seasonal weather change. Data obtained was then compared to global decline in amphibian populations. The study provided insight into several potential threats that roads pose for aquatic species. The study found that low flying Chimney Swifts and Tiger Salamanders that were using the bog as a stopover and/or breeding area resulted in ephemeral exposure to vehicle hazards; in addition, the analysis documented significant wildlife mortality to the Northern Leopard Frog where roads bisect wetlands which indicates the potential of significant impacts on populations of threatened or endangered species (Glista, DeVault, & DeWoody, 2008).

2.2.5(b) Railroads

Indiana rail system totals over 8,000 miles, providing transportation options for freight and passenger services. Based on INDOT's Indiana State Rail Plan,

> Indiana's rail system ranks high among other states in a number of rail-related categories. For instance, Indiana ranks among the top 10 states in rail tons originated, total rail tons carried, total rail carloads carried, and rail employment and wages. In terms of commodities, it also ranks in the top 10 among states for coal tonnage originated and terminated, farm products originated, food products originated, primary metals originated and terminated, and petroleum products terminated (Indiana Department of Transportation, November 2011).

With existing rail infrastructure and future transportation needs, aquatic resources face permanent and long term threats.

The construction of new rail corridors can result in a series of environmental impacts to the aquatic environment. Identified impacts associated with rail projects can significantly impact streams, wetlands, water quality, habitat, flora and fauna, including endangered and threatened species, and biologically sensitive areas (Deakin, 2010). The need for new rail sightings and corridors can be in direct response to development and industry. Field crops, bio-fuels, coal, manufacturing and steel are identified as industry developments that could impact major rail commodities within Indiana (Indiana Department of Transportation, November 2011). In addition to potential industry developments, existing industry that utilize rail infrastructure as a means to transport goods contribute to aquatic threats. The coal industry has been identified as an industry that could impact rail commodities; however, Indiana's domestic coal distribution has been dominated by rail. Indiana railroads deliver 25,436 thousand short tons of coal per year, which comprises 74.6% of all modes of domestic coal transport (U.S. Department of Energy, 2016).

Many of the identified aquatic resource threats associated with roadways transcend to railroads. Both the construction disturbances and the fragmentation that linear rail corridors require result in conversion of wetland and stream habitats. The construction and use of railroads contributes to the fragmentation of natural areas, loss of habitat, ecological disturbance, barrier effect and mortality due to collisions (Van Der Grift, 1999).

Railroad corridors can contribute to major disruptions in stream process when located in the floodplain. Railroad beds are constructed at higher grades, creating lateral disconnection of stream systems causing significant ecological damage (Blanton & Marcus, 2009). Although roadbeds can create a similar effect, typical railroad construction results in a more constrained stream system, due to the linear levee effect they create. These floodplain disconnections result in riparian forest loss, loss and/or simplification of stream and floodplain habitat, and terrestrial and aquatic loss of species richness and diversity which disrupts aquatic resource functions (Blanton & Marcus, 2009).

Future passenger transportation needs may be met through high-speed passenger rail, which typically requires dedicated rail lines for frequent, high-speed trips between urban centers. These high-speed rail projects will require new easements and acquisition of linear corridors for new railroad construction.

2.2.5(c) Service Corridors

Pipelines and corridors associated with oil and gas operations pose several threats to Indiana's aquatic resources. Impacts associated with the construction and maintenance of pipeline corridors result in permanent and temporary aquatic resource impacts that can have lasting negative effects to stream and wetland systems. Pipeline construction activities impact wetland functions due to increased soil compaction and erosion; loss of wetland habitat for dependent wildlife species, terrestrial vegetation impacts that result in loss of habitat and species diversity; potential for colonization by non-native and/or invasive species; wildlife mortality, habitat fragmentation; and permanent wetland loss in response to filling activities (Soli, 2015).

Pipeline corridors located through stream and river systems pose a multitude of threats to these aquatic resources. The construction and maintenance of these corridors can result in increased sedimentation, alterations in stream flows during construction, and changes in stream morphology (Soli, 2015). Both construction activities and natural fluvial processes can threaten infrastructure placed within streams and rivers. As stream systems adjust to geomorphic conditions resulting from either anthropogenic or natural changes within the system, they become unstable. Erosion can expose pipelines buried under rivers and streams making them more susceptible to damage or rupture from strong currents (Ramirez Jr. & Mosley, 2015). Responsible parties for these pipelines are tasked with identifying exposed infrastructure and obtaining permits to armor/repair the reach of stream where the pipeline has been exposed due to erosion and stream instability. Many times this is a temporary fix due to the instability in the channel or natural channel migration.

When pipeline corridors are installed within streams and rivers, they are threatened by the dynamic nature of fluvial systems. Similarly, pipeline maintenance poses permanent effects to aquatic resources. Pipeline spills can result in significant damage to the aquatic environment and the leading causes for pipeline releases are punctures or damage from equipment, corrosion, pipe defects, improper installation, and natural hazards such as ground movement, weather, lightning, and stream currents (Ramirez Jr. & Mosley, 2015).

Installing pipeline infrastructure within or adjacent to sensitive aquatic areas increases the potential for degradation of these sensitive habitats. Based on information from the U. S. Fish and Wildlife Service (USFWS), wildlife refuges in the Midwest Region have over 28 liquid pipelines that transport crude oil, and refined petroleum products including gasoline, diesel, and jet fuel; in addition, their refuges are bisected by over 70 gas pipelines that transport natural gas and other gases, when combined they total approximately 150 miles of liquid and gas pipelines (Ramirez Jr. & Mosley, 2015). These pipelines bisect portions of Indiana and directly impact its national wildlife refuges. The Patoka River National Wildlife Refuge, which is a part of the USFWS-Midwest Region and located in southwestern Indiana, has four major pipelines within its boundary (U.S. Fish and Wildlife Service, April 2014). As pipelines bisect these diverse and sensitive natural areas, the fish and wildlife and aquatic ecosystems that comprise these Refuges are threatened by the likelihood of infrastructure failures.

Similar to impacts associated with the construction of any linear project, electric transmission lines pose many of the same threats to aquatic resources. Transmission line construction activities within stream systems impact water quality by increasing water temperatures in response to vegetative removal, impact flow regimes and processes due to improper installation and maintenance of temporary structures, damage stream banks and increase erosion (Public Service Commission of Wisconsin, July 2013).

Wetlands are subject to similar threats, when constructing new corridors for transmission lines. The installation of transmission towers, substations and related infrastructure can result in permanent impacts when constructed or sited through any wetland community. A ten year study conducted on a shrub/bog wetland located within a powerline corridor, revealed its vegetation exhibited poor recovery from disturbance (Andrews, 1990). Forested wetland communities experience poor recovery potential due to tree limitations within transmission line corridors. The resulting right-of-way maintenance activities contribute to habitat fragmentation, dispersion of invasive species, and loss of native plant species diversity (U.S. Fish and Wildlife Service, 2015).

The delivery of liquid and gas products and electricity are transported within each region of the state as shown in **Figure 13**.

As each of these service corridors extend throughout the state, they require rights-of-way that disrupt and fragment native plant communities and aquatic resources. These pipelines can result in aquatic impacts during their installation and ongoing, intermittent impacts due to maintenance activities. Maintenance practices within utility corridors allow vegetation to regrow but, due to cutting, mowing or spraying of herbicides, vegetation is maintained into an early successional stage, which affects plant and animal communities within the easement (Andrews, 1990). Similar to previously mentioned right-of-way maintenance impacts, native plant species experience an overall loss in species diversity and these practices promote the spread of invasive species (U.S. Fish and Wildlife Service, 2015); in addition, these practices impact animal communities by habitat fragmentation, edge effects that disrupt natural communities, and resulting barriers that maintained corridors create for wildlife (Andrews, 1990).

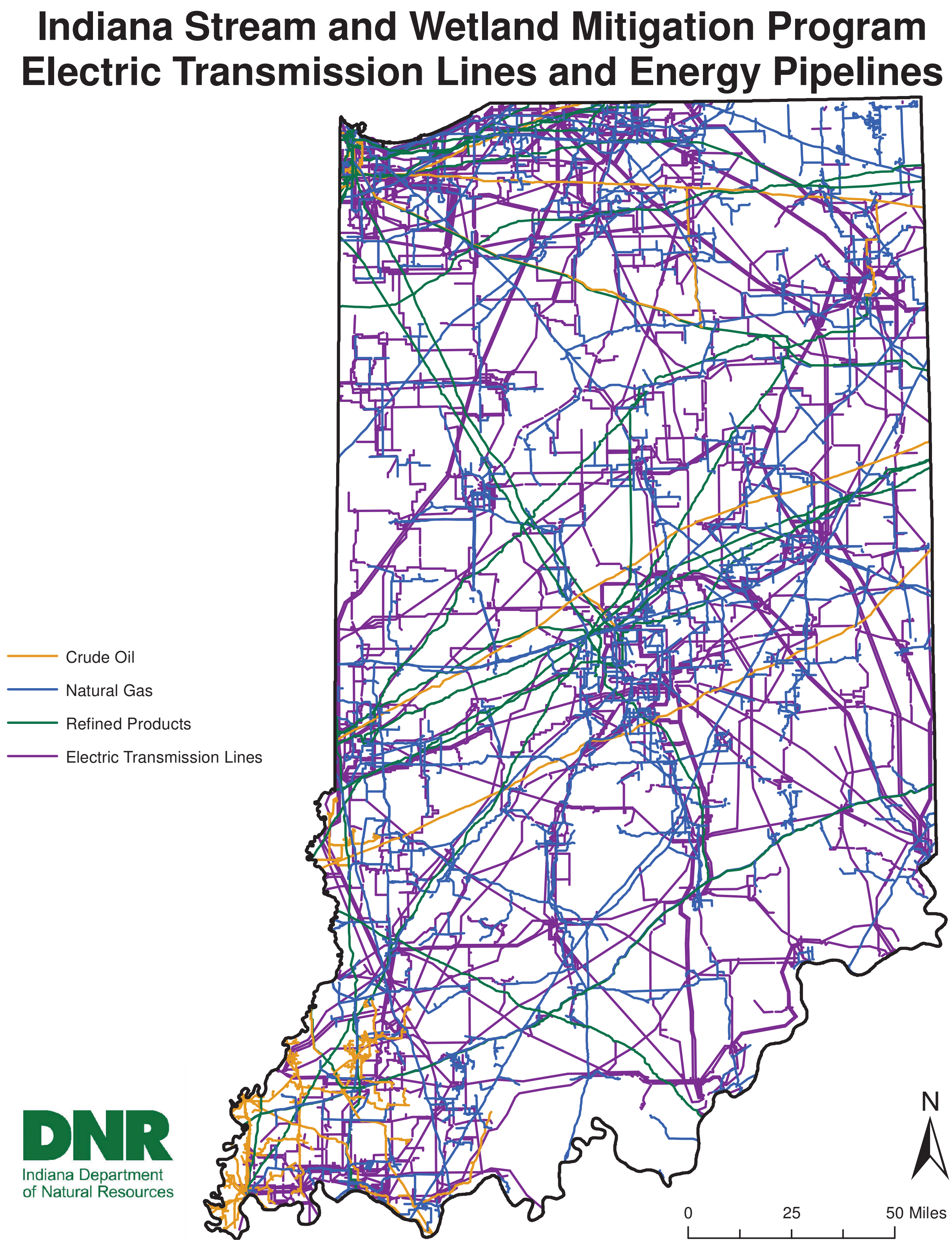

Figure 13. Indiana Pipelines and Transmission Lines. (Indiana Geological Survey , 2015) (Indiana Geological Survey, 2001)

Similarly, electric transmission lines result in permanent linear conversion of natural communities. The installation of a 65 mile 345 kV transmission line project located in southwestern Indiana resulted in permanent impacts to approximately 16 acres of wetlands. The majority of these impacts were due to permanent conversion of forested wetlands within the project right-of-way. The scale and scope of transmission line corridor impacts to aquatic resources is correlated to obtaining better efficiency and higher voltage needs as old infrastructure is updated. New transmission line corridors increase is based on the voltage size. For example, 69 kV transmission line corridor generally require 60 feet wide corridor, 138 kV line require 100 feet, 345 kV require 150 feet and 765 kV line typically require 200 feet (Ginter, 2016). When existing transmission lines are upgraded to a greater voltage, these permanent corridor width requirements resulted in additional impacts to aquatic resources for these upgraded lines. It is expected that as demand for electricity increases, more upgrades to aging energy infrastructure will be required and will result in additional permanent impacts to aquatic resources that will require mitigation.

In summary, these linear corridors fragment habitats which result in threats to aquatic ecosystems. Habitat fragmentation of aquatic ecosystems can affect the dispersal of riverine taxa; when roads and pipelines cross streams, especially via culverts, they often create barriers to dispersal, separating and isolating upstream and downstream populations from one another (Brittingham, Maloney, Farag, Harper, & Brown, 2014).

2.2.5(d) IN SWMP Offsets for Transportation and Service Corridor Impacts:

IDNR's IN SWMP will help offset impacts from transportation and service corridors by targeting compensatory mitigation projects, utilizing a watershed approach, which will improve the quality and quantity of aquatic resources while addressing the unique needs of each service area. Those offsets include:

- Increase habitat connectivity by targeting stream and/or wetland mitigation projects that provide critical linkages to existing conservation areas.
- Remove stream culverts within proposed stream mitigation project segments in order to remove barriers to aquatic passage whenever possible.
- Establish native vegetative communities and help eradicate invasive species, associated with vegetative degradation from linear projects.
- Restore fluvial processes by implementing natural stream restoration projects on streams that experience degradation from transportation and service corridor projects.
- Create wetland mitigation projects that provide the greatest ecological lift in functions that are negatively affected by transportation and service corridor projects.
- Protect high quality wetlands and stream corridors that provide important aquatic functions and services to the watershed that have been impacted from transportation and service corridor projects.

ELEMENT 3. Historic Aquatic Resource Loss

Since 1800s European settlement, the state of Indiana's landscape has been influenced by increases in population growth and development of urban areas as well as agriculture. These influences, along with the use of new technologies, have resulted in Indiana's aquatic resources suffering both quantitative and qualitative losses. Indiana's pre-settlement landscape is estimated to have been comprised of roughly 88% forest (20.4 million acres) and 12% non-forest (2.8 million acres) land cover on a statewide scale (Lindsey, Crankshaw, & Qadir, 1965). It's estimated that over 24% (5.6 million acres) of these forested and non-forested communities were wetlands (Amlaner & Jackson, 2012).

Although Indiana's presettlement landscape was predominately forested, the state was comprised of a multitude of natural communities and subsequent aquatic resource types. The understating of these natural communities has been subject to the compilation of information dating back to the early 1800, such as early geological mapping and General Land Office surveyor's notes. Indiana's natural regions have been defined by (Homoya, Abrell, Aldrich, & Post, 1985) in, "The Natural Regions of Indiana." Homoya et al identified Indiana's natural communities by determining distinctive assemblages of features with the integration of soils, glacial history, presettlement vegetation, topography, climate, exposed bedrock, physiography, flora and fauna distribution throughout the state, and details of various aquatic resource types that dominated the state before European settlers permanently transformed its landscape. **Figure 14**, illustrates the Natural Regions of Indiana boundaries and sections, along with the respective IN SWMP Service Areas boundaries. Although this provides a statewide depiction of the regions, the specific makeup of these natural regions will be detailed within each respective Service Area portion of this document. Additionally, each SA's natural regions map is supplemented with historic natural community composition tables that highlight additional research and surveys that assist in the understanding of the historic composition of each SA's aquatic resources. The tables detail GIS analysis of the percent land cover of each natural region and sections; land cover distribution of mapped hydric and partially hydric soils from Soil Survey Geographic (SSURGO) Database; and the estimated percentage of forested land cover which was adapted from (Lindsey, Crankshaw, & Qadir, 1965)'s "Soil Relations and Distribution Map of the Vegetation of Presettlement Indiana," (1965). This publication provides a generalization of Indiana's presettlement vegetation types, circa 1820.

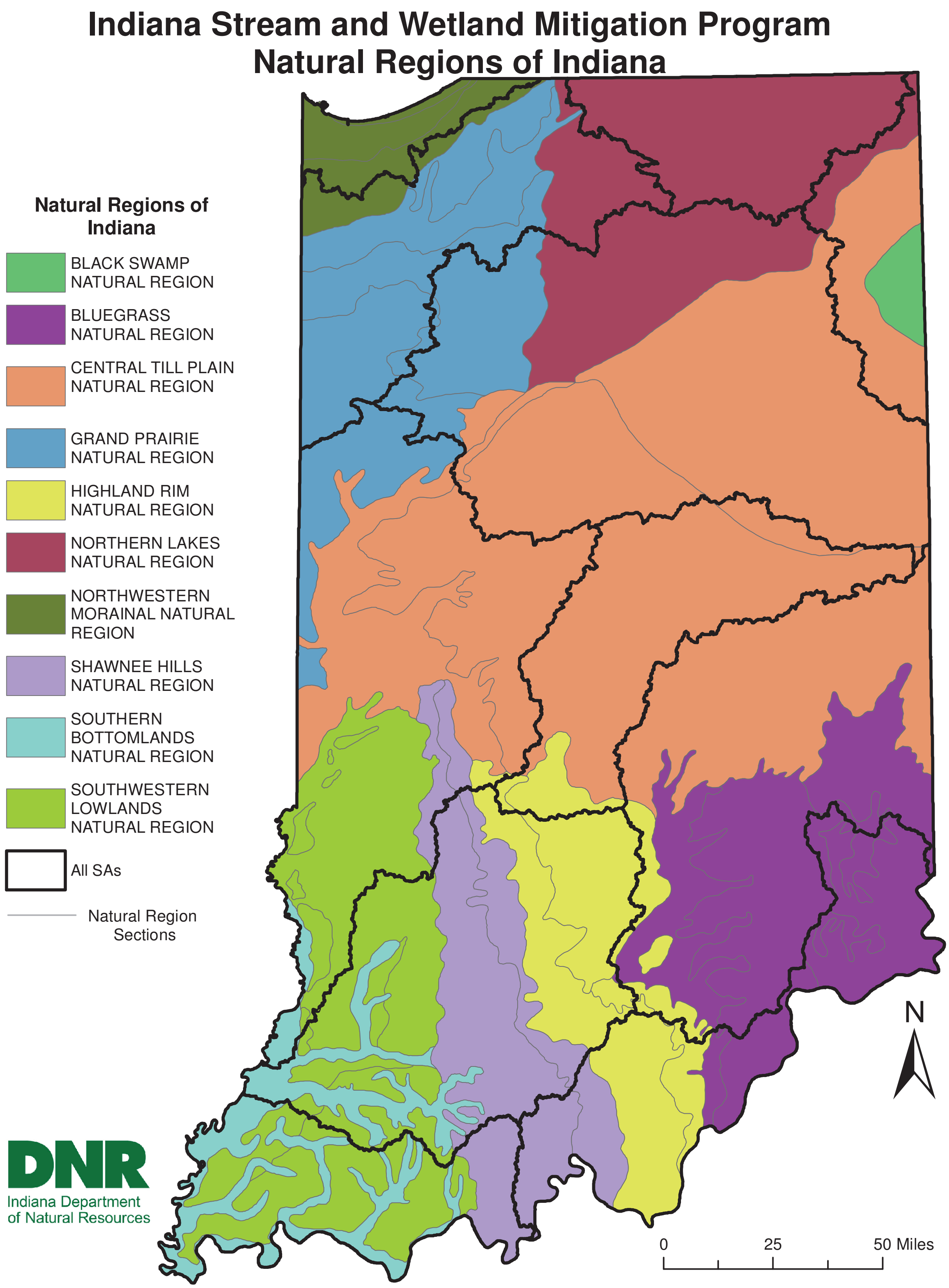

Figure 14. Natural Regions of Indiana (Homoya, et. al. 1985)

Although the state's aquatic resources had experienced relatively minimal disturbance until the 1800's, America's major land acquisitions fueled westward expansion. Population pressure and the lack of productive farmland in the eastern states accelerated full-scale settlement of Indiana and its surrounding states (U.S. Department of Agriculture , 1987). This growth led to the exploitation of its natural resources and natural communities, permanently altering Indiana's landscape. After 1860, forest clearing, wetland draining, and plowing of prairies was wide spread throughout Indiana (Amlaner & Jackson, 2012). Within 20 years, approximately fourteen million acres of the state, which accounts for 61% of the States total acreage, were being farmed (Dahl & Allord, 1996). Once drained, wetlands were transformed into row crops.

Keeping former wetlands from reverting was a major hurdle for early farmers. In order to manipulate hydrology, drainage ditches were constructed in wetlands. Farmers would use teams of oxen and plows to cut two to three feet deep drainage ditches through wetland areas (Jackson M. T., 1997) Although this was the common tool for gaining farmable land; this practice was outpaced by the efficiency of subsurface tile drainage installation. Tiles became a standard practice for wetland conversion by the mid 1800's. Indiana had over 30,000 miles of drain tiles operating by 1882 which converted thousands of acres of wetlands into productive agricultural land (Jackson M. T., 1997).

Forests were timbered to supply raw materials for development, primarily for lumber and fuel. It is estimated that as much as 10 million acres of forestland was cleared across the state (Jackson M. T., 1997). Infrastructure and transportation contributed to the loss of forested wetlands in Indiana. Trees were harvested to construct roads and bridges for infrastructure, provide building supplies, and to construct and fuel railroads. Since early European settlement (circa 1800), Indiana and Ohio have experienced the highest rate of deforestation within the United States (Evans, Donnelly, & Sweeney, September 19, 2009).

The widespread deforestation of Indiana's forests resulted in ancillary impacts to streams and rivers. Dams were constructed to provide water power for the processing of felled timber. There were 1,248 operating sawmills throughout Indiana by 1840; and they were processing up to 1,000 board feet of lumber per day (Jackson M. T., 1997).

Indiana's waterways provided food, power and transportation. Indiana's streams were channelized to facilitate the construction of canals as a means for commerce and transportation. Canals contributed to Indiana's growth with, "agricultural expansion and the export of agricultural surpluses, the import of eastern merchandise, and economic diversification towards manufacturing and commerce" (Indiana Historical Bureau, 1997). Although Indiana's network of canals became obsolete due to the more favorable economics of railroads, their construction negatively impacted wetlands and streams throughout the state. Riparian wetlands were destroyed by clearing and dredging during canal construction (Dahl & Allord, 1996).

Based on societal views during the mid-1800s, draining and converting wetlands was encouraged by State, local and federal governments, and supported by law. Nationwide, wetlands were targeted by the Swamp Land Act of 1850; this increased the states authority to lead the initiative to drain wetlands and construct levees for flood control (Mitsch & Gosselink, 2000). Although this Act relinquished federal control of poorly drained areas to the states, the impetus to drain these aquatic features was established. Indiana was granted authority to drain approximately 1,259,231 acres of swamp lands, as a result of the federal Swamp Land Act of 1850 (Dahl & Allord, 1996).

The southwestern region of Indiana has been altered and influenced by surface and underground coal mines. This region of the state contains unique geological deposits that comprise the Indiana Coalfield, an area that covers approximately 6,500 square miles and constitutes the eastern-most part of the Illinois coal basin (Hatch & Affolter, 2002).

Early 1800's mining techniques utilized pick, shovel and horse-drawn scrapers on the surface and at outcrops; however, the majority of coal production in Indiana during the 1800's to the early 1900's was through underground mining (Powell, 1972). During this time, the primary driver for coal extraction was domestic use. As energy demands increased for industrial uses, efficiencies in coal extraction led to new mining methods and equipment. Open pit strip mining with large steam powered shovels and draglines allowed mines to recover nearly all coal in contiguous cuts and became the dominant mining technique (Powell, 1972).

Surface disturbances for coal extraction not only resulted in stream and wetland losses, but the lack of mine reclamation resulted in long lasting damaging effects to the region's environment. Acid mine drainage was and continues to be a concern for Indiana's wetlands and streams as acidic waters resulting from coal mining leaches into the ground and downstream surface waters degrading water quality and preventing the establishment and longevity of aquatic fauna and flora (Amlaner & Jackson, 2012).

Indiana's natural communities have been and continue to be altered by anthropogenic activities. Early European settlers made major alterations to the landscape as a means of survival. Over the past 200 years, the permanent alterations to Indiana's landscape have resulted in conversion, degradation and fragmentation of native natural communities and degradation of the state's aquatic resources. Despite the changes in Indiana's landscape, high quality remnants remain, many of them preserved by the IDNR, federal government and non-profit conservation organizations over the last century. Finally, many restoration opportunities remain throughout the state to increase and improve the functions and services of Indiana's aquatic resources.

ELEMENT 4. Current Aquatic Resource Conditions

Since the beginning of European settlement, Indiana's aquatic resources have experienced quantitative loss and degradation of the chemical, physical and/or biological integrity of those resources. Aquatic systems continue to be impacted by threats such as habitat loss, conversion, alteration, fragmentation and degradation from urban development, deforestation, agricultural establishment, transportation and utility corridors, point and nonpoint source discharges, and channelization (Amlaner & Jackson, 2012).

The 2016 Indiana Integrated Water Monitoring and Assessment Report (IR or the 305(b) report) prepared by IDEM and submitted to the U.S. EPA is the most comprehensive and up-to-date report on state water quality, and is updated every two years (IDEM-IR, 2016). IDEM's Watershed Assessment and Planning Branch in the Office of Water Quality assesses the chemical, physical, and biological conditions of Indiana's aquatic resources (excluding wetlands) based on Indiana's water quality standards (327 IAC 2), which define the designated uses that the state's waters must support (IDEM-IR, 2016). IDEM assesses state waters for beneficial uses such as aquatic life use support, recreational use support, fish consumption (PCBs and Mercury in fish tissue), and drinking water for surface waters that serve as a public water supply (327 IAC 2). IDEM assesses the most current data for the purposes of compiling the 305(b) report and the 303(d) list of impaired waters using IDEM's consolidated assessment and listing methodology (CALM) (IDEM-IR, 2016). Data collection efforts conducted by IDEM are outlined in Indiana's Water Quality Monitoring Strategy and stored in the Assessment Information Management System (AIMS) database (IDEM-IR, 2016). AIMS contains surface water chemistry data, fish and macroinvertebrate community data, assessments of habitat quality, results from algal monitoring, as well as fish tissue and sediment contaminant data (IDEM-IR, 2016). Reporting tables and figures for Indiana streams, lakes, reservoirs and groundwater are found in the 2016 IR appendices. IDEM has the following water quality monitoring programs that contribute to CWA Section 305(b) assessments:

- Probabilistic Monitoring Program
- Fixed Station Monitoring Program
- Contaminants Monitoring Program
- Performance Measure Monitoring Program
- Special Studies Program
- Watershed Characterization Program

IDNR will rely on IDEM assessment data, among other appropriate statewide and regional sources, to remain up-to-date with the current conditions of Indiana's aquatic resources and will be one of many tools used in the IDNR's prioritization strategy for assessing and selecting compensatory mitigation sites using a watershed approach.

4.1 Streams and Rivers

Based on IDEM's Indiana Reach Index developed for the purposes of mapping Indiana's 305(b) assessments and 303(d) listings, Indiana has approximately 63,130 miles of rivers, streams, ditches and drainage ways (IDEM-IR, 2016); however, streams not included on the USGS National Hydrography Dataset (NHD), such as ephemeral headwaters (USGS, 2016), are not included in the IN Reach Index. A significant portion of Indiana streams are channelized or are man-made ditches, however, records of channel modifications, if they exist, are mostly retained in hard copy within each county and therefore the total reach of these alterations has not been determined.

According to the 2016 IR, approximately 68 percent of the 37,693 stream miles assessed for aquatic life use were found to be fully supporting, leaving approximately 32 percent of assessed miles as impaired. Approximately 74 percent of the 31,683 stream miles assessed for full body contact do not support recreation use. Pathogens are found to be the main source of stream impairments, impacting more than 23,000 miles of streams. More than 4,900 miles of stream contain fish with polychlorinated biphenyls (PCBs) in their tissue and 760 stream miles with mercury in fish tissue. Nearly 8,300 assessed stream miles also have impaired biological communities (IBC) with measurable adverse response to pollutants. Potential sources impacting Indiana waters include nonpoint sources that impact 16,040 miles of streams, while unknown sources impact almost 10,000 miles of streams. A summary of designated use support is provided in **Table 5**.

Designated Beneficial Use	Total (Miles)	Assessed (Miles)	Percent Assessed	Fully Supporting (Miles)	Not Supporting (Miles)
Full Body Contact (Recreational Use)	63,130	31,683	50%	8,122	23,561
Human Health and Wildlife (Fishable Use)	63,130	8,873	14%	3,418	5,455
Public Water Supply	365	25	7%	0	25
Warm Water Aquatic Life (Aquatic Life Use)	63,130	37,693	60%	25,793	11,900

Table 5. Summary of designated use support for streams and rivers from IDEM 2016 Integrated Report and 305(b) assessment database, (IDEM-IR, 2016).

Following are the definitions of Categories 4A and 5 of impaired waters which do not fully support one or more of their designated uses as outlined in U.S. EPA's "Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act" (U.S. EPA, 2003).

Category 4A (**Figure 15**): Segments are placed in Category 4A when all TMDLs needed to result in attainment of all applicable WQSs have been approved or established by EPA.

Category 5 – 303(d) Listing Waters (**Figure 16**)**:** Segments are placed in Category 5 when it is determined, in accordance with the State's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause an impairment or threat; therefore requiring the development of a TMDL.

To gain a better initial understanding of the physical conditions and habitat structure of Indiana's streams, IDNR examined and mapped IDEM's 1991-2014 dataset of Qualitative Habitat Evaluation Index (QHEI) overall scores for stream reaches sampled for fish and/or macroinvertebrate community structure in each service area (IDEM OWQ, 2014). The QHEI is a method developed by the Ohio EPA for assessing habitat in flowing waters, and has been adapted for Indiana to sample streams and rivers regardless of drainage area size (Ohio EPA, 2006), (Rankin, 1995). QHEI reaches are a segment of a stream equal in length to 15 times the average wetted stream width, with a minimum length of 50 meters and a maximum length of 500 meters (IDEM, 2010). The QHEI is not required or used alone to list a stream as impaired for aquatic life use; rather, the QHEI is designed to evaluate the lotic habitat quality important to aquatic communities, and is used in conjunction with macroinvertebrate Index of Biotic Integrity (mIBI, a community assessment score) or fish community IBI data, or both, to evaluate the role that habitat plays in waterbodies where impaired biotic communities (IBC) have been identified (IDEM-IR, 2016). The QHEI, most recently updated for Indiana in 2009, assesses the following major individual metrics, each with individual scoring components: 1) Substrate; 2) Instream Cover; 3) Channel Morphology; 4) Riparian Zone; 5a) Pool Quality; 5b) Riffle Quality; and 6) Gradient. The major metrics are calculated for a total maximum score of 100, with the overall QHEI score rating in the narrative range in **Table 6**. A higher QHEI score represents a more diverse habitat for colonization of aquatic organisms (Ohio EPA, 2006).

QHEI Score		Narrative Rating
>64		Habitat is capable of supporting a balanced warm water community
51 - 64		Habitat is only partially supportive of a stream's aquatic life designation
<51		Poor habitat

Table 6. QHEI narrative ratings and score for QHEI (IDEM, 2008).

The narrative ratings for the 4,217 reaches in which IDEM sampled and collected QHEI data between 1991 and 2014 for Indiana streams is summarized in **Table 7**. These QHEI ratings are mapped for each service area and are located within that service area's discussion later in this document. This data shows that approximately one-third of the stream reaches assessed have poor habitat quality, one-third are only partially supportive and another third are cable of supporting a balanced warm water community.

QHEI Narrative Rating	Total Reaches	Percentage of Total
Poor Habitat	1,451	34%
Partially Supportive	1,325	31%
Supporting	1,441	34%
Total	**4,217**	**100%**

Table 7. Statewide QHEI scores and sampled reaches. (IDEM OWQ, 2014)

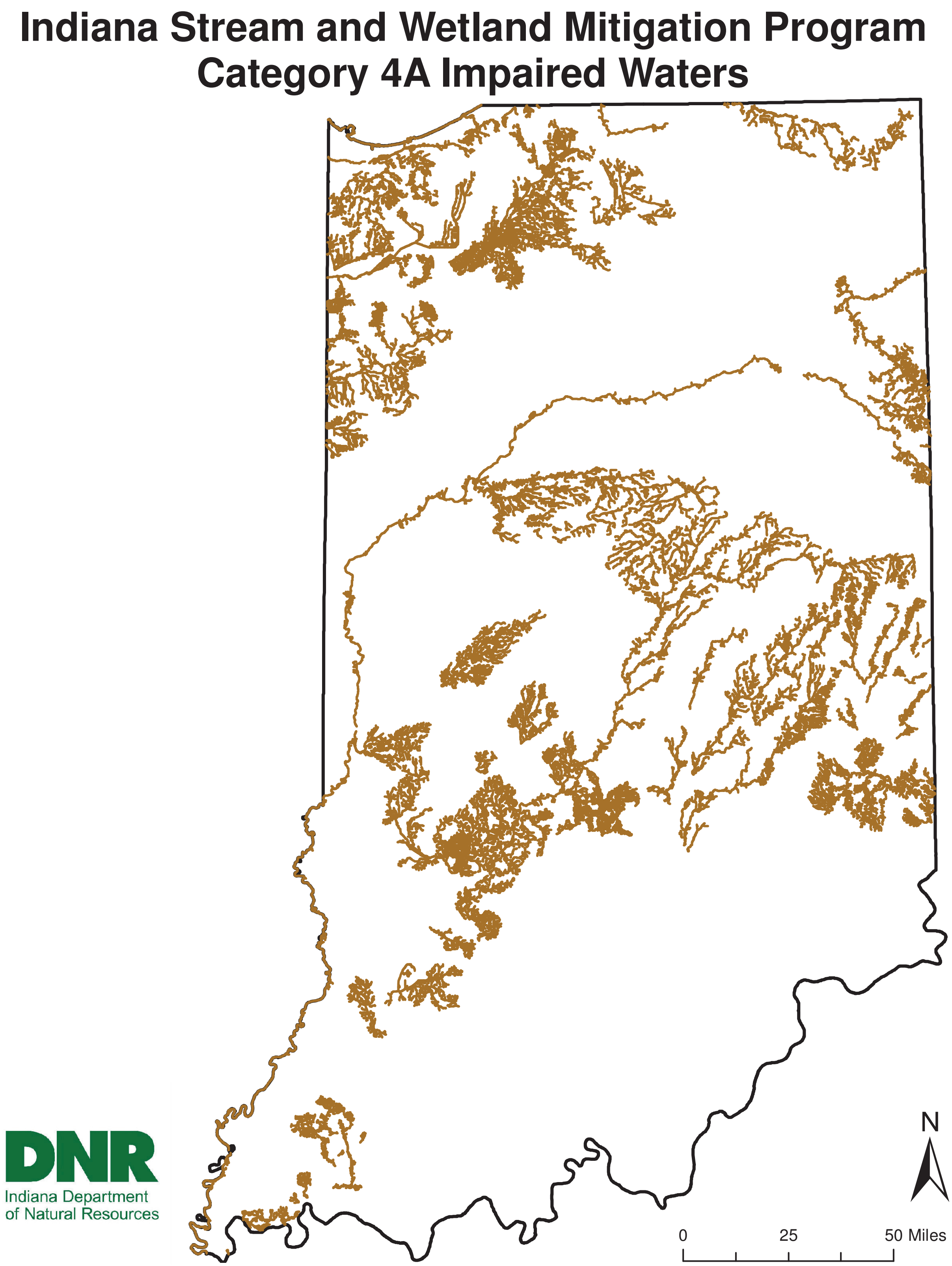

Figure 15. Category 4A impaired waters, (IDEM-IR, 2016)

Figure 16. Category 5 impaired waters, (IDEM-IR, 2016)

A component to the QHEI is “bank erosion and riparian zone” which includes metrics for the width of the riparian zone, whether any erosion is present, and composition/land use of the flood plain. Floodplains with forested/swamp/wetland with no erosion and greater than 50 meter wide riparian buffer receiving the highest score for this particular metric. The ecological functions and services provided by forests are extremely important to the chemical, physical, and biological integrity of streams and other aquatic resources. Both forested uplands and aquatic resources such as forested wetlands and riparian areas provide ecological and hydrologic functions and services such as soil stabilization and development, stream bank stabilization, nutrient and contaminant filtering, peak runoff and flow attenuation, infiltration to ground water, ground and stream shading, and critical wildlife habitat (Brauman, Daily, Duarte, & Mooney, 2007). The significant reduction in Indiana’s forested cover indicates that the ecological and hydrological functions and services that forests provide have been diminished. A reduction or lack of forested cover is a significant contributor to impaired aquatic resource functions and critical wildlife habitat conditions statewide.

To gain a better understanding of where diminished forest cover may be impacting the functions and services of Indiana’s streams, a GIS analysis was completed to identify headwater streams with a forested riparian area width of less than 100 feet located within the agricultural settings of cultivated crops and pasture/hay per the 2011 NLCD (Homer, et al., 2015). Approximately 68,969,843 linear feet (13,062 miles) of headwater streams with a riparian corridor of less than 100 feet in width within an agricultural setting were identified (**Table 8**). This information will be used as an additional tool by IDNR when assessing and prioritizing potential stream mitigation projects.

Service Area Name	Potentially Restorable Headwater Streams (Linear Feet)
Calumet-Dunes	378,082
St. Joseph River (Lake MI)	1,220,086
Maumee	2,779,740
Kankakee	3,231,953
Upper Wabash	12,677,175
Middle Wabash	12,258,927
Upper White	4,122,307
Whitewater-East Fork White	11,818,126
Lower White	9,248,485
Upper Ohio	3,559,241
Ohio-Wabash Lowlands	7,765,720
Total	**68,969,843**

Table 8. Linear feet of potentially restorable headwater streams in Indiana with less than 100ft of riparian buffers within an agricultural setting. These numbers are estimates based on GIS evaluation completed by Ducks Unlimited

4.2 Wetlands

The Indiana Wetlands Program Plan identifies altered hydrology, impaired water quality, isolation and fragmentation of wetland habitats, invasive species, failed mitigation, and unaccounted functional losses as major concerns attributed to current wetland conditions in Indiana (IWPP, 2015). Current wetland degradation is attributed to agricultural activities, residential, commercial and industrial development, road construction, water development projects, groundwater withdrawal, loss of instream flows, water pollution, and vegetation removal (IDNR, 1996). In addition to significant historic loss, wetlands in Indiana continue to be lost at a rate of approximately one to three percent each year (Kim, Ritz, & Arvin, 2012).

IDEM routinely assesses water quality data on streams and lakes throughout the state, but does not collect assessment data for wetlands (IWPP, 2015). Additionally, Indiana does not currently have a fully implemented standardized assessment methodology, or water quality standards specific for wetlands (IWPP, 2015). Approximately 96% of Indiana's land is privately owned (IASWCD, 2016), making it more logistically difficult to conduct on-the-ground conditional assessments of wetlands as compared to streams. According to the Indiana Department of Administration's "State Property Facts at a Glance" dated May 2010, the State of Indiana only owns 1.7% (394,631 acres) of the total land, while the federal government owns approximately 2% (470,000 acres) (IDOA, 2010).

The most extensive database of the extent of wetland resources in Indiana is the National Wetlands Inventory (NWI). It was originally developed by the U.S. Fish and Wildlife Service (USFWS) in the 1980's (IWPP, 2015), updated in Indiana in 2009 by Ducks Unlimited (Ducks Unlimited, 2010), and was officially published for the public within the USFWS NWI Wetland Mapper in September of 2011 (USFWS NWI, 2015) (**Figure 17**). The updated NWI for Indiana utilized quality 2005 aerial photography and improved methodology while maintaining the Cowardin, *et al*. classification scheme (Ducks Unlimited, 2010), (Cowardin, Carter, Golet, & LaRoe, 1979). The updated NWI is more accurate in identifying wetland locations, extent, types and trends than the original 1980's version (IWPP, 2015).

As part of the 2009 NWI update for Indiana, Ducks Unlimited conducted a comparative analysis of the original and the updated NWI (Ducks Unlimited, 2010). The overall accuracy of the updated GIS NWI delineations based on field verifications was 86%. The overall accuracy of the updated wetland Cowardin classifications was 79%. There was a four year period of time between the 2005 aerial photography used for the NWI analysis and the 2009 field verifications, which may account for some of the misclassifications.

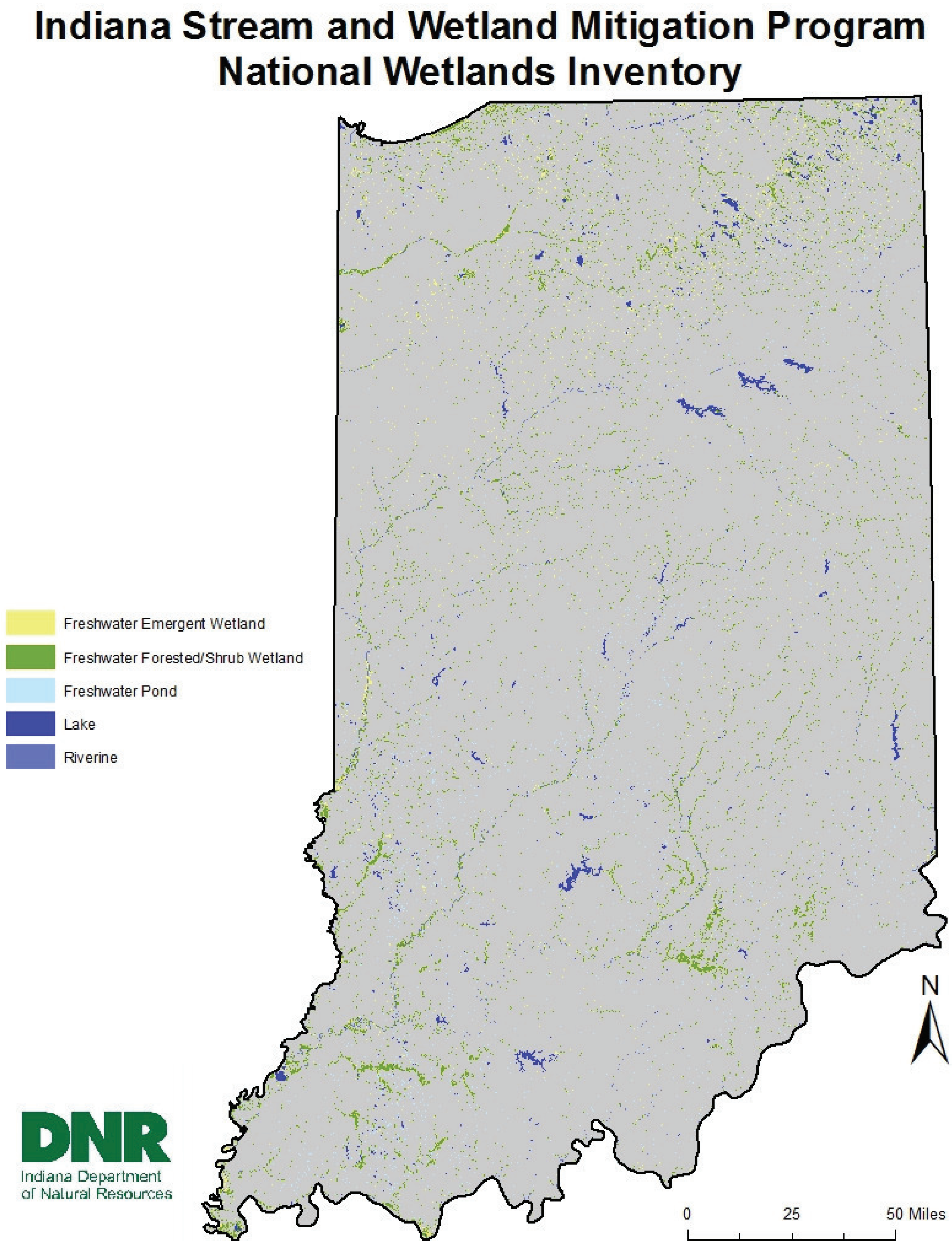

Figure 17. National Wetland Inventory for Indiana (USFWS NWI, 2015)

The total number of individually identified wetlands that were fully converted from the time of the original NWI of the 1980's to the time of the updated NWI in 2005 was 31,952, while 4,991 individual wetlands were partially converted (**Table 9**). The cumulative acreage of fully or partially converted wetlands totaled 45,416 acres (**Table 10**) at an average size of 1.23 acres. Agricultural land use accounted for 72% of wetland conversions and development was the second largest at 24%.

	Agriculture		Development		Recreation		Other		
	Number	%	Number	%	Number	%	Number	%	Total
Fully Converted	24,588	76.95%	6,109	19.12%	210	0.66%	1,045	3.27%	31,952
Partially Converted	2,529	50.67%	1,972	39.51%	144	2.89%	346	6.93%	4,991
Total	**27,117**	**73.4%**	**8,081**	**21.87%**	**354**	**0.96%**	**1,391**	**3.77%**	**36,943**

Table 9. Number of wetlands converted by conversion type (1980-88 to 2005)

	Agriculture		Development		Recreation		Other		
	Acres	%	Acres	%	Acres	%	Acres	%	Total
Fully Converted	25,023	79.2%	5,722	18.11%	369.8	1.17%	477.5	1.51%	31,593
Partially Converted	7,895.24	57.12%	5,090.9	36.83%	527.4	3.82%	309.59	2.24%	13,823
Total	**32,918.3**	**72.48%**	**10,814**	**23.81%**	**897.2**	**1.98%**	**787.03**	**1.73%**	**45,416**

Table 10. Acreage of wetlands converted by conversion type (1980-88 to 2005)

Emergent wetlands accounted for 56% of the total individual wetlands converted, with open water at 25% and forested wetlands at 13% (**Table 11**). Emergent wetlands accounted for 48% of the total converted wetland acreage, while converted forested wetlands accounted for 32% (**Table 12**). The individual size of a converted forested wetland was typically larger than that of a converted emergent wetland.

	Aquatic Bed		Emergent		Forested		Scrub-Shrub		Open Water		Shore		Other		
Converted	#	%	#	%	#	%	#	%	#	%	#	%	#	%	Total
Fully	**222**	**1%**	**19,285**	**60%**	**2,336**	**7%**	**1,094**	**3%**	**8,812**	**28%**	**149**	**0%**	**54**	**0%**	**31,952**
Partially	**30**	**1%**	**1,380**	**28%**	**2,559**	**51%**	**385**	**8%**	**607**	**12%**	**4**	**0%**	**26**	**1%**	**4,991**
Total	252	1%	20,665	56%	4,895	13%	1,479	4%	9,419	25%	153	0%	80	0%	36,943

Table 11: Number of wetlands converted by wetland class (1980-88 to 2005)

	Aquatic Bed		Emergent		Forested		Scrub-Shrub		Open Water		Shore		Other		
Converted	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	**Total**
Fully	**113**	**0%**	**18,392**	**58%**	**6,216**	**20%**	**2,072**	**7%**	**4,294**	**14%**	**177**	**1%**	**330**	**1%**	**31,593**
Partially	**20**	**0%**	**3,319**	**24%**	**8,328**	**60%**	**924**	**7%**	**489**	**4%**	**6**	**0%**	**737**	**5%**	**13,823**
Total	133	0%	21,711	48%	14,543	32%	2,996	7%	4,783	11%	183	0%	1,066	2%	45,416

Table 12. Acres of wetlands converted by wetland class (1980-88 to 2005)

There were a total of 60,346 additional individual wetlands added to the inventory totaling 102,486 acres (**Table 13**). Wetlands identified in the NWI update that were not in the original are not necessarily new wetlands. Rather the scale and quality of the 2005 aerial photography was better than that of the original, accounting for additional wetlands with an average size of 1.7 acres which was below the minimum size of the original NWI mapping scale (Ducks Unlimited, 2010).

	Aquatic Bed		Emergent		Forested		Scrub-Shrub		Open Water		Shore		Other		
Additional	%		%		%		%		%		%		%		Total
Acres	**419**	**0%**	**26,723**	**26%**	**6,450**	**6%**	**1,494**	**1%**	**43,479**	**42%**	**0**	**0%**	**23,922**	**23%**	**102,486**
Number	**387**	**1%**	**9,325**	**15%**	**1,677**	**3%**	**573**	**1%**	**48,124**	**80%**	**0**	**0%**	**260**	**0%**	**60,346**
Avg. Size Acres	**1.08**		**2.87**		**3.85**		**2.61**		**0.9**		**0**		**92.01**		**1.70**

Table 13. Number and acres of additional wetlands by wetland class (1980-88 to 2005)

Though additional individual wetlands were identified, and there was a gain in emergent wetland, aquatic bed and open water acres, there was a documented loss of forested, scrub-shrub, and shore wetlands (**Table 14** and **Table 15**). Open water accounted for the majority of the additional acres, though the individual waterbodies averaged under an acre in size, and were mostly small private pond or retention basins.

	Aquatic Bed		Emergent		Forested		Scrub-Shrub		Open Water		Shore		Other		Total
Number	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	
Converted	252	1%	20,665	56%	4,895	13%	1,479	4%	9,419	25%	153	0%	80	0%	36,943
Additional	387	1%	9,425	15%	1,677	3%	573	1%	48,124	80%	0	0%	260	0%	60,346
Total	**135**		**-11,340**		**-3,218**		**-906**		**38,705**		**-153**		**180**		**23,403**

Table 14. Net change in wetland numbers from 1980-88 to 2005

	Aquatic Bed		Emergent		Forested		Scrub-Shrub		Open Water		Shore		Other		Total
Acres	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	
Converted	133	0	21,711	48%	14,543	0%	2,996	7%	4,783	0%	183	0	1,066	2%	45,416
Additional	419	0	26,723	26%	6,450	6%	1,494	1%	43,479	42%	0	0	23,922	23%	102,486
Total	**285**		**5,012**		**-8,094**		**-1,503**		**38,696**		**-183**		**22,856**		**57,070**

Table 15. Net change in wetland acreage from 1980-88 to 2005

Additionally, regional wetland information is reported in the USFWS's Status and Trends of Wetlands in the Conterminous U.S, 2004 – 2009. The report indicates that Indiana is located within a region with the highest rate of freshwater wetland loss to upland, and also experienced a decline in emergent wetland area (Dahl T. , 2011).

Since there is currently a gap in ground-truthed wetland data in Indiana, it is important to quantify wetlands that have been converted to other land uses by evaluating mapped hydric and partially hydric soils in these areas to further demonstrate that there are major deficiencies in the potential of wetland functions and services in Indiana due to the extent of wetland conversion and loss. An IDNR wetlands analysis from 1991 estimated that Indiana had lost approximately 86 percent of historic wetlands, reduced from approximately 24.1 percent (5.6 million acres) of total land cover circa 1780, to 3.5 percent (813,032 acres) cover as of the 1980's (IDNR, 1996).

In order to determine the approximate amount of converted wetlands that are potentially restorable within the state of Indiana, hydric and partially hydric soils from the Soil Survey Geographic (SSURGO) Database (NRCS-USDA, 2016) within the footprint of the potentially restorable land cover types of cultivated crops and pasture/hay from the 2011 National Land Cover Database (Homer, et al., 2015) were analyzed. Existing PFO, PSS and PEM wetland acres from the NWI (USFWS NWI, 2015) mapped within agricultural land use cover were then removed to obtain a net of potentially restorable wetland acres. Based on this analysis, it is estimated that out of the 23,139,288 acres of Indiana's total land, approximately 4,046,664 acres (17.5%) are hydric and approximately 4,199,550 acres (18.2%) are partially hydric, of which 3,260,944 mapped hydric acres and 3,117,129 partially hydric acres are currently within the footprint of agricultural land use. Per the NWI, there are approximately 552,633 acres of PFO, PSS and PEM wetland types mapped within and/or that interestect the 2011 NLCD agricultural footprint which were then subtracted from the hydric and partially hydric soils total, resulting in a net of 5,825,442 acres of potentially restorable wetlands statewide (**Table 16**). This data analysis is a good starting point for further identifying loss of wetland functions and services, and for locating potential restoration sites. This information will be used as another potential tool when assessing and prioritizing for wetland mitigation projects, and has been analyzed further per each SA's current aquatic resource conditions discussion to identify above average concentrations of wetland loss while also contributing to the program's aquatic resource restoration goals and objectives for prospective wetland restoration opportunities.

Service Area	Hydric Soils w/in Ag. Land Use		Partially Hydric Soils w/in Ag. Land Use		PFO, PSS, PEM Wetlands from NWI w/in Ag. Land Use	Net Potentially Restorable Wetlands
	Acres	% of SA	Acres	% of SA	Acres	Acres
Calumet-Dunes	15,695	4.1%	13,629	3.5%	11,072	18,251
St. Joseph River	69,860	6.4%	171,975	15.8%	63,179	178,657
Maumee	136,627	16.6%	324,658	39.5%	19,979	441,306
Kankakee	549,179	28.7%	305,536	15.9%	45,872	808,844
Upper Wabash	1,038,235	23.5%	1,025,262	23.2%	108,193	1,955,304
Middle Wabash	494,339	14.3%	374,622	10.8%	77,676	791,286
Upper White	291,355	16.7%	382,861	22.0%	25,618	648,599
Whitewater-East Fork White	377,350	11.5%	462,763	14.1%	76,597	763,515
Lower White	146,847	5%	10,986	0.4%	63,334	94,500
Upper Ohio	7,177	0.4%	44,832	2.6%	8,215	43,794
Ohio-Wabash Lowlands	134,281	10%	3.37	0.0%	52,897	81,387
Statewide Total	**3,260,944**	**14.1%**	**3,117,129.09**	**13.5%**	**552,633**	**5,825,442**

Table 16: Potentially restorable wetlands within agricultural land use

4.3 Lakes, Reservoirs and Ponds

Indiana has more than 1,400 natural lakes, reservoirs, and ponds (IDEM-IR, 2016). The Indiana Clean Lakes Program (CLP) was created by IDEM in 1989, and is administered through a CWA Section 319(h) grant to Indiana University's School of Public and Environmental Affairs (SPEA) – IU Bloomington (Indiana Clean Lakes Program, 2016). The CLP is a statewide public lake management program consisting of components of public information and education, technical assistance, volunteer lake monitoring, lake water quality assessment, trophic state trends, aquatic invasive species monitoring (as of 2012), and coordination with other state and federal lake programs (Indiana Clean Lakes Program, 2016). The CLP has sampled over 500 lakes statewide, and all the information and data is available on the CLP website. The CLP provides all lake data to IDEM for use in CWA Section 305(b) assessments, 303(d) listings, and IR biennial reports (IDEM-IR, 2016). In addition, the CLP tracks trends in individual lakes, identifies lakes that need special management, and tracks water quality improvements due to industrial discharge and runoff reduction programs (Indiana Clean Lakes Program, 2016).

Many of Indiana's lakes, reservoirs and ponds have excessive nutrient concentrations, nuisance algae, excessive plant growth, as well as murky water and/or odor (IDEM-IR, 2016). These impairments have been greatly attributed to anthropogenic causes such as poorly managed agriculture, suburbanization of lakeshores, boating impacts and septic system discharges (IDEM-IR, 2016). A summary of designated use support for lakes and reservoirs from the 2016 IR is found in **Table 17**. A summary for Lake Michigan is found in the Calumet-Dunes Service Area.

Designated Beneficial Use	Total Size (acres)	Size Assessed (acres)	Percent Assessed	Size Fully Supporting (acres)	Size Not Supporting (acres)	Size Not Attainable (acres)
Full Body Contact (Recreational Use)	127,539	37,041	29%	29,035	8,006	0
Human Health and Wildlife (Fishable Use)	127,539	77,845	61%	27,290	50,555	0
Public Water Supply[1]	29,541	16,615	56%	230	16,385	0
Warm Water Aquatic Life (Aquatic Life Use)	127,539	10,379	8%	3,754	6,625	0

Table 17. Designated use support for freshwater lakes and reservoirs in Indiana from IDEM's 2016 IR and assessment database (IDEM-IR, 2016). [1]While all waterbodies in Indiana are designated for aquatic life and recreational uses, not all are designated for public water supply. There are a total of 29,541 lake acres designated for drinking water in Indiana

IDEM identifies nutrients as the number one cause of impairment to Indiana lakes and reservoirs. Additionally, pathogens (E.coli), thermal impacts, toxic organics (PCB's), metals (Mercury), mineralization, pH, and algae (chlorophyll-a) are also significant contributors to current lake impairments (IDEM-IR, 2016). The main sources impairing lakes and reservoirs include runoff (nonpoint source) from agriculture and animal feeding operations, industrial permitted discharges, acid mine drainage, combined sewer overflows, and urban-related runoff and storm water discharges (IDEM-IR, 2016). Lake impairment data from the IR and information from the CLP will be valuable prioritization tools utilized by IDNR for assessing and siting potential compensatory mitigation projects.

4.4 Ground Water and Surface Water Interaction

Though ground water is not directly regulated under Section 404 of the CWA, impacts to surface water resources, in addition to many other land use activities, affect the quantity and quality of groundwater (IDEM-IR, 2016). Conversely, groundwater quantity and quality often directly affect surface waters (Winter, Harvey, Frank, & Alley, 1998). Nearly all types of surface water interact with groundwater, either by surface waters recharging groundwater and/or groundwater discharging to surface waters (Winter, Harvey, Frank, & Alley, 1998). This interaction greatly influences both ground water driven hydrology for wetlands and base flow conditions for streams and rivers.

As part of 305(b) ground water assessments, the IDEM Ground Water Section identifies the following as the top ten priority contaminant sources: commercial fertilizer applications, confined animal feeding operations, animal manure applications, underground storage tanks, landfills constructed prior to 1989, septic systems, shallow injection wells (Class V), industrial facilities, materials spills (including during transport), and salt storage and road salting (IDEM-IR, 2016). The type of contaminants most commonly associated with groundwater contamination include inorganic pesticides, organic pesticides, halogenated solvents, petroleum compounds, nitrate, salinity/brine, metals, radionuclides, bacteria, protozoa and viruses (IDEM-IR, 2016).

IDEM identifies an aquifer's hydrogeologic sensitivity as the most significant risk factor when considering the degree of a contaminant's threat to groundwater (IDEM-IR, 2016). In order to estimate groundwater recharge rates in shallow unconsolidated aquifers, the Indiana Geologic Survey (IGS) with support and data from IDEM created a data set to support a statistical analysis and create a mapping tool to spatially represent recharge across Indiana (**Figure 18**) (Letsinger S. L., 2015). In order to support decision making where knowledge of sensitivity to aquifer contamination is desired, the IGS with support and data from IDEM created a data set and mapped near surface aquifer sensitivity in Indiana (**Figure 19**) (Letsinger S. , 2015). In conjunction with other watershed considerations, IN SWMP will consider groundwater recharge rates, especially those that are slow or sensative, when assessing and identifying wetland mitigation needs.

Additionally, significant surface and ground water withdrawal or interception can result in reduced groundwater recharge and base surface flows. Indiana's Water Resource Management Act (IC 14-25-7) requires the owners of significant water withdrawal facilities to register with the DNR and report water use on an annual basis. A "significant water withdrawal facility" (SWWF) is defined in the statute to mean "the water withdrawal facilities of a person that, in the aggregate from all sources and by all methods, has the capability of withdrawing more than 100,000 gallons of ground water, surface water, or ground and surface water combined in one (1) day." The IDNR Division of Water (DOW), Water Rights and Use Section currently maintains records of approximately 4,068 active SWWFs, representing about 7,204 ground-water wells and 1,351 surface water intakes (**Figure 20**) (IDNR DOW, 2016). SWWF's records as of 2015 are presented in each SA. The DOW Resource Assessment Section also has ongoing groundwater quantity assessment data collection and publications that may contribute to the IDNR's assessment and prioritization of compensatory mitigation projects. DOW groundwater assessments include base flow mapping to understand the groundwater-surface water connection for watersheds; groundwater potentiometric surface mapping used to map flow direction, recharge, discharge, and changes in static water levels over time; and consolidated (bedrock) and unconsolidated aquifer mapping used to show geologic materials characteristics, thickness of confining units, aquifer thickness, static water levels, well yield, typical well depths, and depth to aquifer resource.

Indiana Stream and Wetland Mitigation Program
Aquifer Recharge Near Surface

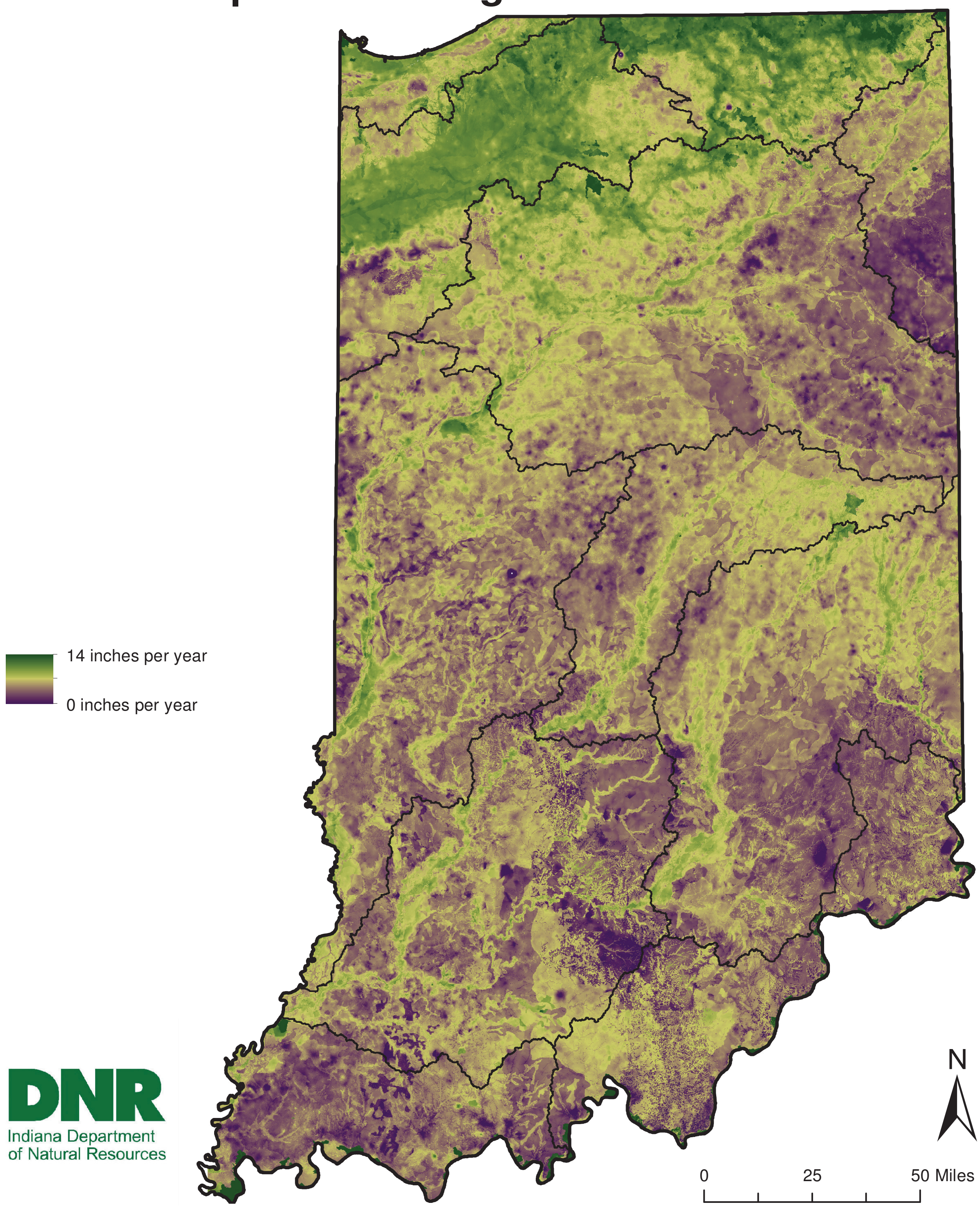

Figure 18. Groundwater recharge rates to shallow aquifers, Indiana Geological Survey (Letsinger S. L., 2015)

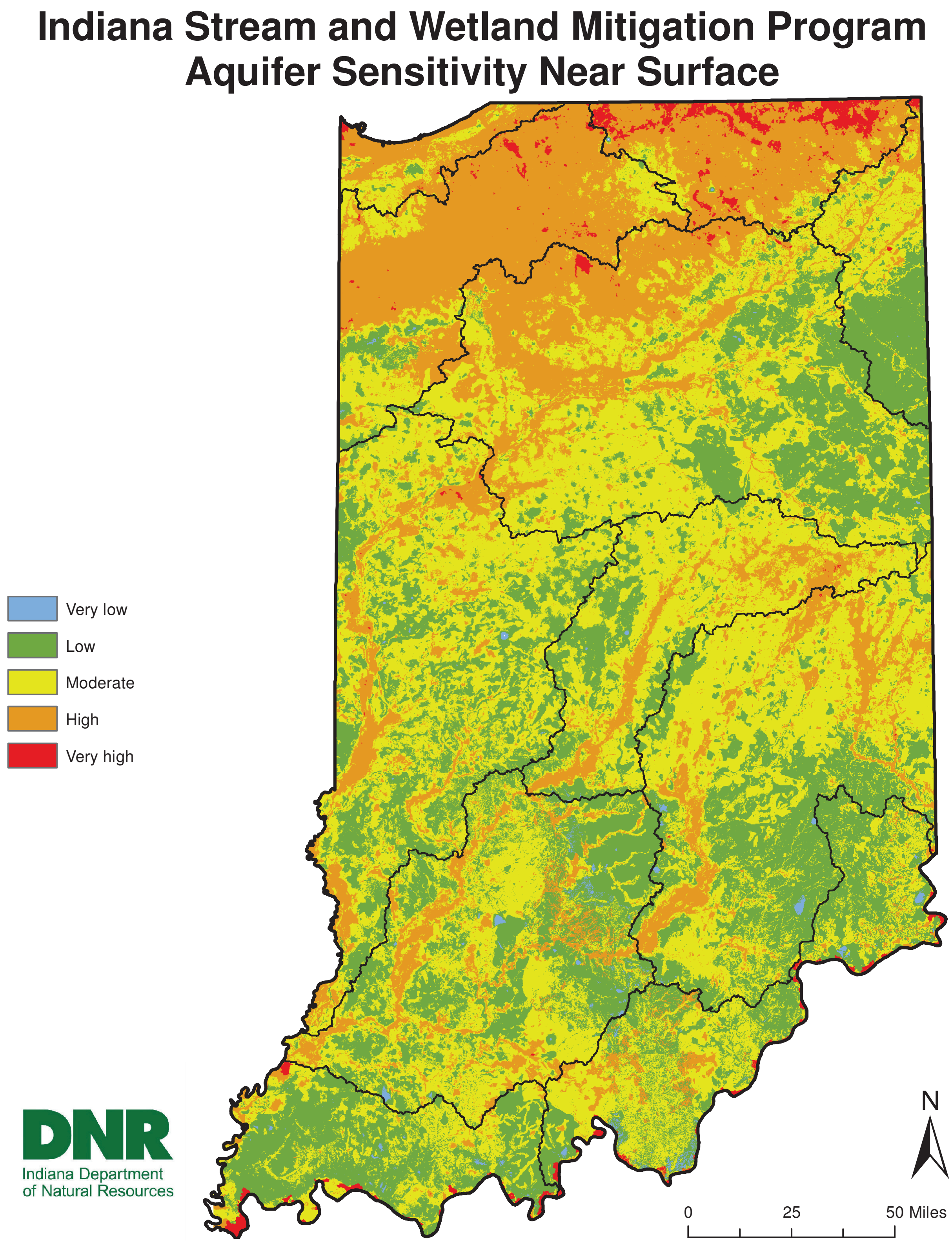

Figure 19. Aquifer sensitivity in shallow aquifers, Indiana Geological Survey (Letsinger S. , 2015)

Indiana Stream and Wetland Mitigation Program
Registered Significant Water Withdrawal Facilities

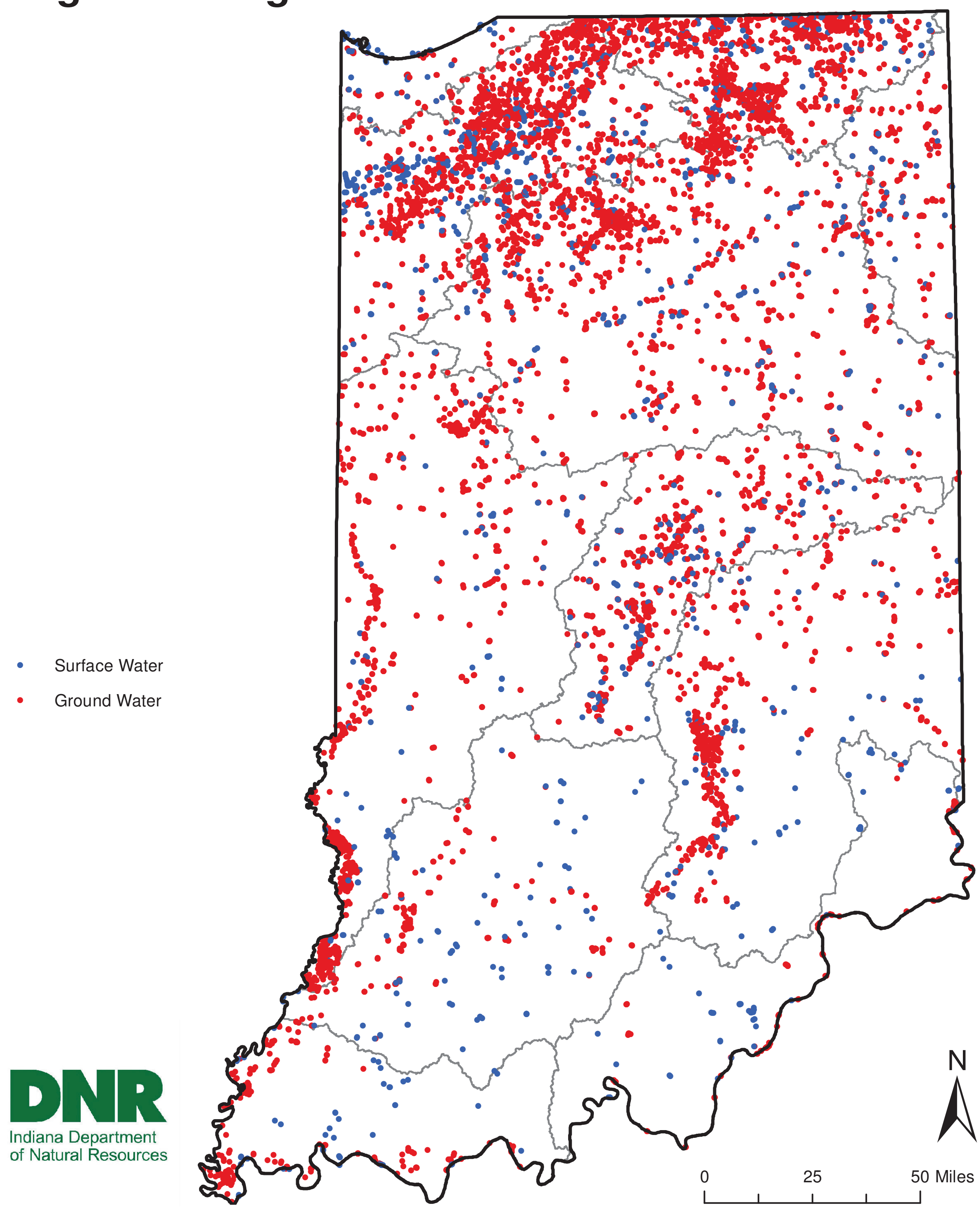

Figure 20: Registered Significant Water Withdrawal Facilities – 2015 (IDNR DOW, 2016). Capacity of 100,000 gallons per day for both ground water and surface water

4.5 Invasive Species

As a result of habitat conversion, fragmentation and degradation of aquatic resources, there has been a decline in the number and diversity of native aquatic/wetland and terrestrial plant species, including many that have been extirpated (Amlaner & Jackson, 2012). Part of this reduction is also due to the introduction of non-native, invasive species such as purple loosestrife, glossy buckthorn, and Eurasian strains of common reed and reed canary grass, among a host of others (Amlaner & Jackson, 2012). In response to this increasing problem, the Legislative Council of the Indiana General Assembly directed the Natural Resources Study Committee to investigate invasive species issues which resulted in the creation of the Invasive Species Task Force (ISTF) in 2007 (Indiana Invasive Species Council, 2008). In 2009, based on the recommendation of the task force, the Indiana General Assembly established the Indiana Invasive Species Council (IISC) within the Purdue University College of Agriculture to enhance the ability of the state agencies to detect, prevent, monitor and manage new and long established invasive species (IC 15-16-10 – Invasive Species Council). Among many other efforts within their mission, the IISC maintains an official invasive plant list which ranks invasiveness and provides current IN legal status (IISC, 2016).

Invasive plants in Indiana are referred to in statutes as exotic weeds, noxious weeds and detrimental plants. Jurisdiction over invasive plant species is divided between the Department of Natural Resources (IC 14-24-2-1), Office of Indiana State Chemist (IC 15-15-1-14, 18, 20, 25, 40, 41), County Weed Boards (IC 15-16-7-2), and township trustees (IC 15-16-8-12). Per the ISTF, though invasive species are well documented and rapidly increasing in the state, little is known on the current locations (exact distributions) since there is currently no agency responsible for tracking invasive plant locations in Indiana; and just as importantly, where they are not (Indiana Invasive Species Council, 2008). In response to this shortfall, the IISC implemented Report IN in 2014, which is a system for reporting invasive species in Indiana to include plants, insects, diseases and wildlife (IISC, 2016). Report IN is managed through the Early Detection and Distribution Mapping System (EDDMaps), a web-based system for reporting and documenting invasive species distribution (IISC, 2016). Reports can be made on a computer and on the Great Lakes Early Detection Network (GLEDN) smartphone application, with all data maintained in the EDDMaps database (Jacquart, 2014). Report IN will be used to map invasive species distribution, track their movement, and to facilitate early detection and appropriate responses (Jacquart, 2014). Report IN will gain value as more users report invasive species over time, and could prove to be a useful tool for IN SWMP.

Invasive species such as *Phragmites australis* (common reed) and *Phalaris arundinacea* (reed canary grass), along with many other species, degrade much of the wetlands left in the state, reducing biodiversity and natural habitats available for fish and wildlife (Indiana Invasive Species Council, 2008). Invasive plants also negatively impact Indiana's forests and riparian areas by outcompeting native flora, reducing tree and understory growth rates, threatening biodiversity, and degrading natural habitats (Indiana Invasive Species Council, 2008). The state's prairie flora is among the most reduced in number, and almost no areas that were formally prairie have reverted (Amlaner & Jackson, 2012). Most prairie species can still be found, but in scattered, very small remnants that are threatened by herbicides and by non-native species (Amlaner & Jackson, 2012). Additionally, Indiana's aquatic resources are generally rich with nutrients, enabling aquatic invasive species to grow quickly and outcompete native species (Indiana Invasive Species Council, 2008).

As of 2005, there were approximately 899 non-native species of flora documented in Indiana (Amlaner & Jackson, 2012). Approximately 400 native plant species are threatened with decline and possible extirpation from the state, and over 50 species are thought to already be extirpated (Amlaner & Jackson, 2012). The conversion of natural habitats due to the major anthropogenic activitiy categories outlined in this CPF has had significant adverse impacts on fish, wildlife and native botanical resources, and the present extent of these land uses strongly influence invasive species ability to expand in Indiana (Amlaner & Jackson, 2012).

4.6 Preservation of Indiana's Aquatic Resources and Natural Communities

Though the chemical, physical and/or biological integrity of the majority of Indiana's aquatic resources, in addition to the functions and services they provide, are impaired in some way, there are still high quality natural aquatic and upland communities (buffers), and waterbodies that are designated for increased protection. Though the precise extent of all wetland types and locations in Indiana is not known, a group of wetland types known as 'Rare and Ecologically Important Wetland Types' receive priority protection in Indiana under IC 13-11-2-25.8(a)(3)(B) and 327 IAC 17-1-3(3)(B). These wetlands are located in an undisturbed or minimally disturbed setting that supports more than minimal wildlife, aquatic habitat, and/or hydrologic function and include acid bog, acid seep, circumneutral bog, circumneutral seep, cypress swamp, dune and swale, fen, forested fen, forested swamp, marl beach, muck flat, panne, sand flat, sedge meadow, shrub swamp, sinkhole pond, sinkhole swamp, wet floodplain forest, wet prairie, and wet sand prairie.

These rare and ecologically important wetland types also coincide with the natural wetland communities documented in the Indiana Natural Heritage Data Center (NHD), which represents a comprehensive attempt to determine the state's most significant natural areas through an extensive statewide inventory. Indiana has an exceptionally diverse selection of natural habitats, which in turn support high species diversity. To assure adequate methods for evaluating this information and setting sound land protection priorities, the program is designed to provide information about:

- Natural ecosystems
- Endangered, threatened, special concern and rare flora and fauna species
- Landscape features

The Heritage database contains the most comprehensive and up-to-date data with more than 1,000 records of federally endangered species; more than 12,000 records of state-listed species, and more than 1,300 records of high-quality natural communities. The NHD also contains records for more than 700 significant natural areas in the state.

With the dedication of Meltzer Woods, the last unprotected old growth forest in Shelby County, as a nature preserve (NP) on May 19, 2016, Indiana has tallied a total of 50,000 acres protected through dedication as state nature preserves. Indiana's system of nature preserves was established in 1967 with the Nature Preserves Act, IC 14-31, passed by the Indiana General Assembly. The act's purpose is to identify, protect and manage an array of nature preserves and natural areas in sufficient numbers and sizes to maintain viable examples of all of Indiana's natural communities. The IDNR Division of Nature Preserves also manages and maintains viable populations of endangered, threatened and rare species.

The Healthy Rivers INitiative (HRI) was launched in 2010 as the largest land conservation initiative undertaken in Indiana. The initiative includes a partnership of resource agencies and organizations who are working with willing landowners with a goal to permanently protect over 43,000 acres located in the floodplain of the Wabash River and Sugar Creek in west-central Indiana, and over 26,000 acres in the Muscatatuck River bottomlands in southeast Indiana.

These projects involve the protection, restoration and/or enhancement of riparian and aquatic habitats and the species that use them, particularly threatened and endangered species, migratory birds and waterfowl. This initiative also helps to reduce nutrient inputs, connect fragmented habitats, provide flood protection to riparian landowners, and provide increased public access for recreational opportunities. As of 2016, through conservation easements and land acquisition, the HRI has permanently protected over 33,000 acres in the three project areas since 2010.

Additionally, Indiana possesses higher quality streams and rivers documented in statute and rule with more stringent protections, such as the following:

- Indiana Designated Salmonid Waters: 327-IAC-2-1.5-5(a)(3)
- Indiana Designated Outstanding State Resource Waters, all or partially: IC-18-3-2(u), 327 IAC 2-1.3-3(3)(d) and 327 IAC 2-1.5-19(b)
- State Designated Scenic Rivers: 312 IAC 7-2
- State Navigable Waterways: IC 14-29-1

ELEMENT 5. Aquatic Resource Goals and Objectives

The principal goal of the IN SWMP is to provide compensatory mitigation to satisfy IDNR's responsibilities taken on by the sale of mitigation credits to fulfill Corps and/or IDEM permit requirements through restoration, establishment, enhancement, and/or preservation of aquatic resources within the state.

Service area specific goals and objectives are tailored to address unique aquatic resource threats within each of the 11 respective boundaries and are detailed within the respective service area section.

The following **aquatic resource goals and objectives** apply to all service areas:

1. Implement compensatory mitigation projects that improve the quality of aquatic resources within each service area, utilizing a watershed approach, to help offset the predominant statewide threats to Indiana's aquatic resources while also helping to offset unique threats identified in each service area.
2. Establish mitigation projects that contribute to high priority conservation objectives for stream and wetland habitats outlined in Indiana's State Wildlife Action Plan, the Indiana Wetland Program Plan, and/or other state or regional conservation initiatives for Indiana's aquatic resources and dependant habitats.
3. Reduce stream and wetland habitat fragmentation by establishing mitigation projects that improve connectivity by providing critical linkages to exiting conservation areas and/or corridors.
4. Replace wetland and stream types that have experienced historic loss within each service area, while recognizing current hydrological and geomorphological conditions, and establish mitigation projects in areas within each service area that have experienced significant losses of function and services due to the identified threats.
5. Implement projects that can address sources of impairment identified in IDEM 305b reports, 303d list, Total Maximum Daily Load (TMDL) reports, watershed management plans, watershed restoration action strategies and other applicable water quality assessment data, when determined to be feasible, non-detrimental to mitigation success, and mutually beneficial to the aquatic resource restoration objectives.
6. Restore and enhance aquatic habitats on existing and/or adjacent to conservation lands while ensuring long-term management, funding and protection in perpetuity fulfills all requirements set forth in the Federal Mitigation Rule under applicable sections of 33 CFR §332.3; and 33 CFR §332.8.
7. Preserve rare and high quality aquatic resources; critical habitat for rare and endangered species; priority habitat for species of greatest conservation concern; and/or other areas meeting the requirements of 33 CFR §332.3(h).
8. Contribute to ongoing water quality initiatives by working closely with public and private stakeholders at the statewide and service area level.

Project specific goals and objectives will be developed for each mitigation project in which will be evaluated by the Corps and IRT for each individual mitigation proposal. The project specific goals and objectives shall be tailored to address the current site conditions, site constraints, and specific objectives that will help offset threats to Indiana's aquatic resources identified in this document and/or watershed plans. Additionally, the individual mitigation proposal will provide for measurable success of project initiatives and have project-specific performance criteria.

ELEMENT 6. Prioritization Strategy

6.1 Statewide Project Prioritization

IN SWMP projects in all service areas will effectively replace lost aquatic resource functions due to permitted physical impacts. The main goal of mitigation projects within each service area is to restore streams and wetlands as compensation for adverse impacts to aquatic resources permitted through Section 10 of the Rivers and Harbors Act, Sections 401 and 404 of the Clean Water Act (CWA), and Indiana's State Isolated Wetlands law (Indiana Code 13-18-22).

IN SWMP's strategy for project prioritization will adhere to all applicable requirements set forth in the Federal Mitigation Rule, *Federal Register 33 CFR §332.3 & 33 CFR §332.8*. Mitigation project site selection in all service areas will utilize a watershed approach in order to achieve IN SWMP's aquatic resource goals and objectives by selecting projects that will help offset the threats to Indiana's aquatic resources, as described in Element 2, historic loss as described in Element 3, and/or current impaired conditions as described in Element 4. Based on a landscape-watershed approach to aquatic resource restoration, if an approved watershed management plan(s) (WMP) and/or TMDL(s) exist within the service area in which the impact occurred, these plans will be consulted when selecting a mitigation project site to determine if the potential project will assist in fulfilling the goals and objectives of those plans. Likewise, any other applicable data may be utilized to assist in site selection decision making and prioritization.

Aquatic resource impact types that are permitted to utilize IN SWMP for compensatory mitigation will be considered in the selection and implementation of mitigation projects. IDNR will consider compatibility of restoration sites for in-kind replacement and historic aquatic resource loss while considering current conditions. This approach will have the greatest likelihood to effectively replace lost aquatic resource functions and services resulting from permitted impacts, historic loss and/or current impaired conditions.

IDNR will target compensatory mitigation projects that will help to improve the quality and quantity of aquatic resources while helping to address the unique needs within each service area. Priority will be given to project sites that have the greatest increase in ecological functions and services with re-establishment providing the highest level of compensation followed by rehabilitation, establishment, enhancement and then preservation.

6.2 General Criteria for Mitigation Site Identification and Selection

Numerous criteria are involved in the identification of mitigation sites including hydric soils and characteristics, topography, land use trends, ecological benefits, population/growth and development trends, wetland inventory data, protected lands, surrounding geography and landscapes, and physiographic regions.

The **four steps below** present the prioritization criteria for mitigation site identification and selection. This prioritization strategy will be used for project selection within each service area.

When prioritizing sites for mitigation projects, the following **core criteria** shall be utilized.

1. Mitigation site proposals must result in a successful and sustainable net gain and/or preservation of aquatic resource functions and services and/or result in no net loss of Indiana's aquatic resources.
2. Prioritization will be given to compensatory mitigation projects that provide the greatest benefit to the service area, by providing the greatest lift in aquatic resource functions and services based upon the specific needs identified within that service area and/or watershed utilizing the landscape-watershed approach for site selection.
3. Project proposals will consider how to help offset the anthropogenic threats to aquatic resources, historic loss, and/or current impaired conditions while achieving IN SWMP goals and objectives, within each service area.
4. Other evaluation criteria may include, but are not limited to; cost, feasibility, size, proximity to other conservation lands or protected areas, connectivity or location with respect to corridors, human use value (services), and efficient long term maintenance.

In addition to the Core Criteria, information from conservation partners, landowners and additional stakeholders may also be utilized during the site selection process as they may have additional data or a pre-existing list of priority restoration projects. Ground investigations will be required to confirm or dismiss these datasets and determine the best locations for compensatory mitigation project sites.

ELEMENT 7. Preservation Objectives

According to the federal mitigation rule (33 CFR §332.3 (h)), preservation is defined as the removal of a threat to, or preventing the decline of, aquatic resources; this includes activities associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms and does not result in a gain of aquatic resource area or functions.

Under the IN SWMP, preservation actions will be consistent with the watershed approach to protecting aquatic resources. The main objective of preservation mitigation projects is to permanently protect existing waters having a significant contribution to conservation needs within a service area.

Reference to Indiana's current SWAP should be made when identifying habitat threats and management goals; these plans will help determine where greatest preservation and conservation efforts are needed in the state. Consultation with local land trust organizations will be conducted to locate preservation opportunities. Preservation strategies will be based on their ability to relieve these threats and the importance of the resource to the watershed and/or State.

Preservation will be used to provide compensatory mitigation when the following criteria are satisfied (33 CFR §332.3 (3) (h)):

1. The resources to be preserved provide important physical, chemical, or biological functions for the watershed;
2. The resources to be preserved contribute significantly to the ecological sustainability of the watershed;
3. Preservation is determined by the District Engineer, in consultation with the IRT, to be appropriate and practicable;
4. The resources are under threat of destruction or adverse modifications;
5. The preserved sites will be permanently protected though an appropriate legal instrument.

ELEMENT 8. Public and Private Stakeholder Involvement

The IDNR will work diligently with private landowners, federal and state agencies, other conservation organizations, non-governmental organizations, academic institutions, local governments, watershed councils and associations, professional societies, universities, and public land agencies to meet the requirements of the Instrument. Individual mitigation projects will be implemented on private and public lands, and IDNR believes stakeholder involvement will be important to the success of the program. The IDNR will work closely with partners to deliver quality mitigation projects. Since the majority of land in Indiana is privately owned, there will need to be a cooperative effort between private land owners and public agencies.

Potential partners and stakeholders include, but are not limited to:

Federal Agencies

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Department of Agriculture (NRCS)
- U.S. National Park Service
- U.S. Forest Service
- U.S. Department of Transportation
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)

State Agencies

- Indiana Department of Environmental Management
- Indiana Department of Natural Resources
- Indiana Department of Transportation
- Indiana State Chemist Office
- Indiana Department of Health
- Indiana State Department of Agriculture
- Indiana Geological and Water Survey
- Indiana Natural Resource Commission
- Indiana Department of Homeland Security

- Adjoining state governments (shared watersheds)

Other Organizations

- Conservation organizations (Local land trusts, Ducks Unlimited, The Nature Conservancy and similar conservation organizations)
- Indiana Association of Soil and Water Conservation Districts (SWCDs)
- Indiana Association of Regional Councils (IARC)
- Municipal and county governments
- Municipal Separate Storm Sewer Systems (MS4) Entities
- River Basin Commissions
- Conservancy Districts
- Indiana Silver Jackets
- Indiana Conservation Partnership
- Landscape Conservation Cooperative Network (Eastern Tallgrass Prairie and Big Rivers, Upper Midwest and Great Lakes, and Appalachian LLC's)
- Universities
- Active Watershed Management Groups
- Indiana Water Monitoring Council
- Indiana Water Resource Association
- Indiana Clean Lakes Program
- Indiana Invasive Species Council
- Private landowners

In addition to these agencies and organizations, IDNR will conduct public outreach activities to educate the public regarding the mitigation program and to seek local involvement in identifying mitigation projects. The public will also have an opportunity to comment on IN SWMP projects during the public comment period laid out in 33 CFR §332.8(d)4 when mitigation plans are submitted to the District Engineer; participation by the public in this process will be greatly encouraged by the IDNR during each public comment period.

Partners will be able to provide knowledge of the local area and help locate and identify areas for mitigation projects, assist with the development and implementation of monitoring programs, own mitigation sites and provide long-term management for sites they will own.

Additionally, IN SWMP will utilize appropriate existing and future U.S. regional, statewide, and/or state regional planning and guidance documents that were created with significant stakeholder involvement. For example, as part of IDEM's Indiana Wetland Program Plan, a tool was developed for identifying and mapping high priority wetlands conservation sites (HPWCS) (IWPP, 2015). The intention of this tool is to improve tracking of existing high quality wetland sites and target them for protection (including appropriate buffers). In addition, certain wetlands and geographic areas have been identified as priorities due to ecological significance, high potential benefit, or other needs. IN SWMP provides maps of existing high priority aquatic resource conservation areas within each SA. An additional tool that IDNR can utilize is "Potential Wetland Restoration Sites" which was created by IDEM and included as part of the IWPP.

ELEMENT 9. Long-Term Protection and Management Strategies

IDNR shall be responsible for developing and implementing a long-term protection and management plan for each IN SWMP project. IDNR may utilize existing publicly owned property or secure property for inclusion to the public trust. Projects implemented on publicly owned property or property that will be transferred to public ownership shall be protected and managed through appropriate real estate instruments or other mechanisms approved by the District Engineer (DE) and as required by 33 CFR 332. IDNR may also utilize privately-owned properties and will record real estate instruments to guarantee protection of privately-owned properties. Long term management of privately-owned properties will be transferred to an appropriate natural resource management entity with a plan approved by the DE in consultation with the IRT.

IN SWMP projects will be designed, to the maximum extent practicable, to require minimal long-term management efforts once performance standards have been achieved. IDNR shall be responsible for maintaining IN SWMP program projects consistent with the mitigation plan to ensure long-term viability as functional aquatic resources. IDNR shall retain responsibility, unless and until, the long-term management responsibility is formally transferred to a long-term manager with Corps approval. The long-term management plan developed for each IN SWMP project will include a description of anticipated management needs with annual cost estimates and an identified funding mechanism (such as non-wasting endowments, trusts, contractual arrangements with future responsible parties, or other appropriate financial instruments). Other voluntary management activities may be considered as long as no detrimental effects to the mitigation project are realized. Reference to 33 CFR §332.7 (d) shall be made when determining the long-term management plan for each mitigation project.

The final mechanism for long-term protection and management shall be submitted to the IRT for review, and approval will be made by the DE in consultation with the IRT prior to the release of mitigation project credits.

ELEMENT 10. Periodic Evaluation and Reporting

Every 5 years, the IDNR will submit a program findings/evaluation report to the District Engineer (DE) and the IRT as a supplement to the Annual Program Report; this report will address how the goals and objectives set forth in the Instrument are being met in terms of site selection and project implementation.

The report may also include any proposed changes to the Compensation Planning Framework. A review of the resources used to create the Compensation Planning Framework will be conducted during the evaluation. Requested changes to the Compensation Planning Framework will be submitted as an amendment to the Instrument for approval by the DE in consultation with the IRT.

The following sections provide Service Area specific information, details on the status of the aquatic resources, and the specific compensatory mitigation approach and priorities.